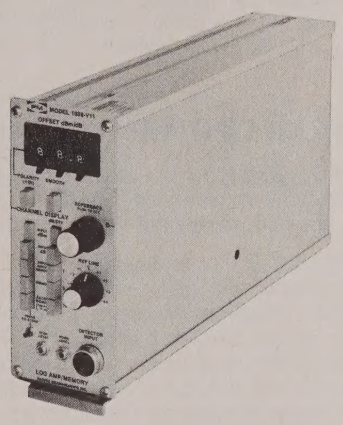
INSTRUCTION MANUAL

VERTICAL LOG AMPLIFIER PLUG-IN UNITS

MODEL 1038-V10
MODEL 1038-V11
MODEL 1038-V12

PM PACIFIC MEASUREMENTS INCORPORATED

INSTRUCTION MANUAL



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MODEL 1038-V12

SERIAL NUMBER 598

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SECTION 1

GENERAL INFORMATION

1.1 DESCRIPTION

The Models 1038-V10, -V11 and -V12 are plug-in units for the Model 1038 measurement system. They fit into either of the right-hand two slots in the Main frame and provide signals to drive the vertical deflection system of the CRT. A horizontal drive plug-in is required to form a complete display system. The input to the vertical plug-in unit comes from a microwave diode detector. Several types are available from Pacific Measurements with frequency range and connector types to satisfy most requirements. In addition, a special adapter cable is available to connect to detectors of other manufacture. The adapter cable will also connect to microwave devices which include internally mounted detectors, such as return-loss bridges.

The input to the horizontal plug-in is generally obtained from sweep voltage generated by a swept-frequency RF source. Accordingly, the horizontal (or X) axis of the CRT scales directly in frequency. The vertical (or Y) axis scales in signal amplitude, expressed in decibels.

In general, the vertical plug-ins will display signal levels from -50 dBm to +10 dBm. The display capability depends somewhat upon the characteristics of the specific detector type used; the dynamic range will be found on the specification sheet for the detector. The plug-in has display sensitivities selectable from 10 dB per division down to 0.1 dB per division. Thus small variations with frequency can be viewed on a sensitive scale with good resolution whereas larger variations can be seen on the less sensitive ranges. For absolute power displays, the dBm button provides accurate calibration. For relative power measurements, the dB button works in conjunction with the Reference knob to make any arbitrary power level the reference.

The reference line can be positioned to any of the nine major horizontal lines on the CRT graticule, using the REF. LINE switch. For example, if the dBm button is depressed and the REF. LINE switch is set to the center position, the trace will cross the screen in the center if 1 mW (0 dBm) is applied to the detector. An OFFSET control allows high-resolution level measurements to be made in much the same way that voltage measurements are made using a differential voltmeter. The sensitivity is made low to begin with and the trace moved to the reference line using the OFFSET control. The sensitivity is successively increased and a better adjustment made with the OFFSET control until the best setting is found. The level (either absolute or relative, as desired) is read off the digit switch.

A more complete understanding of the instrument's capabilities can be had by reading the Operation Section of this manual.

The Models 1038-V11 and -V12 have the same capability as the -V10 and have the additional feature of Automemory.® The feature allows the instrument to record the variations with frequency of the devices used in a microwave measurement set-up. In other words, to record a calibration curve for the measurement system. When subsequent measurements are made, this curve is subtracted from the measured data to give just the variation caused by the device under test. This eliminates tedious plotting of data and graphical subtraction of the measurement data from the calibration data to obtain a corrected curve. The V11 and V12 are identical except that the memory for the V11 is for 256 points horizontally and the V12 is for 1024 points horizontally. Vertical resolution is one 32nd of a division in both units. In order to provide horizontal address information to the vertical plug-in, a horizontal plug-in with memory drive must be used when the memory feature is desired.

1.2 PERFORMANCE SPECIFICATIONS

Detailed specifications for the Models 1038-V10, -V11, and -V12 are given in Table 1-1.

TABLE 1-1

OFFSET CONTROL	
Resolution	3 Digits
Range	±99.9 dB
Accuracy	±.02 dB/10 dB ±.05 dB
DISPLAY SENSITIVITY	
Ranges	0.1, 0.5, 1.0, 5.0, and 10 dB/DIV
Accuracy	±3%
REFERENCE CONTROL	
Range	>±59 dB centered on approximately -20 dBm.
MEASUREMENT RANGE	< -50 to > +10 dBm for a detector with between 0.5 and 1.0 mV dc output for -30 dBm input. Its output resistance must be less than 20 k ohms at -30 dBm.
DRIFT, using Pacific Measurements temperature compensated detectors	
At 0 dBm	<.01 dB/°C (+15 to +45°C)
At -40 dBm	<0.5 dB/24 Hrs. at constant temperature
SYSTEM LINEARITY, using Pacific Measurements detectors	0.1 dB/10 dB. At -50 dBm, an additional 0.5 dB linearity error makes the total 1.1 dB if +10 dBm is the reference.
TEMPERATURE	
Operating	0 to 50° C
Non-operating	-50 to +65° C
DIMENSIONS (H x W x D)	16.8 cm x 6.60 cm x 29.7 cm (6.6" x 2.6" x 11.7")
WEIGHT	2.3 kg. (5 lbs.)

1.3 INPUT/OUTPUT CONNECTOR

The following signals appear on the Input/Output Connector of the Mainframe when the Model 1038-V10, -V11, or -V12 are installed. Refer to the Mainframe manual for additional pin assignments and information.

I/O CONNECTOR PIN NO.	SIGNAL
11	Do not use
12	Do not use
13	External Ratio to A Channel, 100mV/dB*
29	External Ratio to B Channel, 100mV/dB*

* These inputs are available to add marker pips to the display. Input impedance 10KΩ, maximum input 10V.

SECTION 2

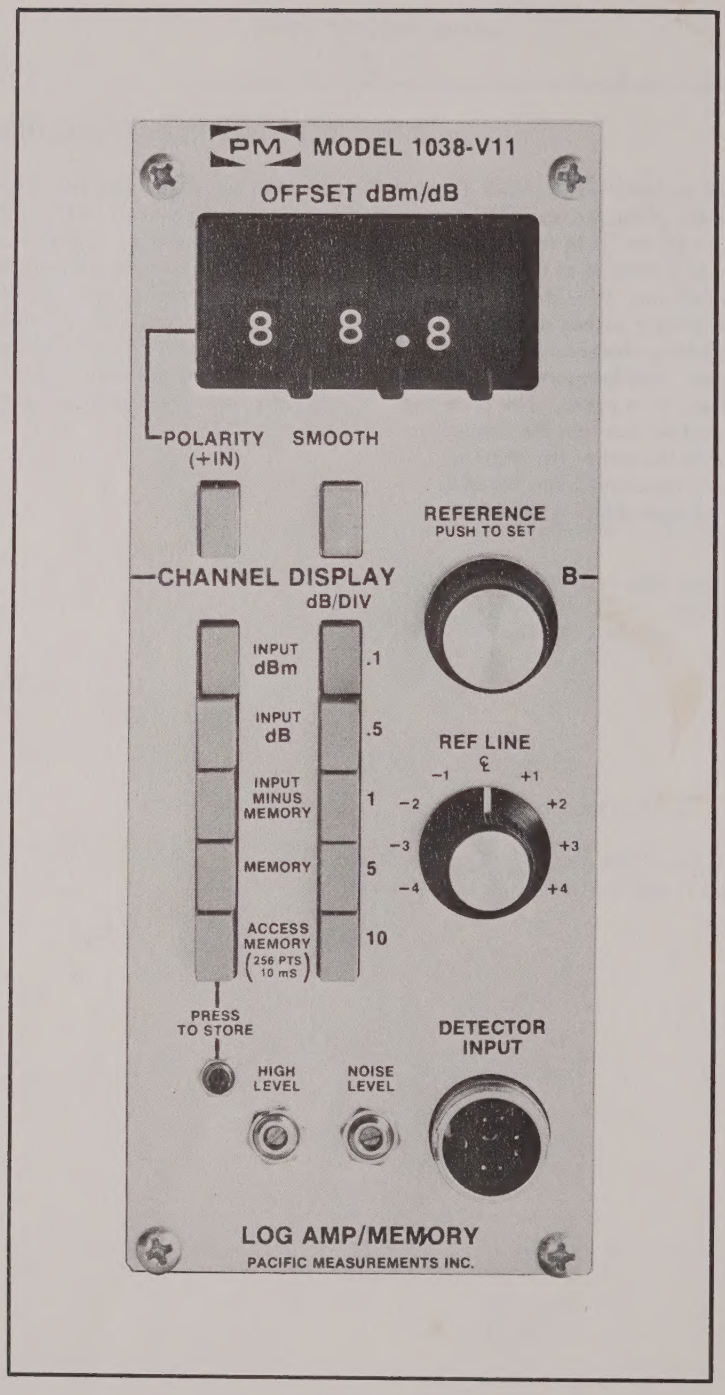
INITIAL INSTRUCTIONS

2.1 INSTALLATION

Vertical plug-in units can be installed in either of the two right-hand locations of the Model 1038 System Mainframe. They will not fit in the left-hand location. A latching lever is located at the bottom of the front panel of the plug-in. It must be pulled straight out before the plug-in is pushed all the way in. After the plug-in can be pushed no further, the lever is moved to the right. This forces the plug-in into the connector and locks it in place. Use care in inserting the plug-in and be sure that the connector at the rear lines up with the end of the plug-in board. This is particularly important when the instrument is first set-up, because shipping damage might cause misalignment.

2.2 DETECTOR CONNECTION

In order to use the vertical plug-in, a detector is required. It connects to the front panel female multi-pin connector. The connector has a keyway in the plastic to mate with the key in the plug. Be sure to align the key with the keyway before pushing the connector together. All detectors will be damaged if too much RF power is applied to them, so be sure to observe the warning affixed to the detector. In most cases you should not exceed 50 mW (+17 dBm).



FRONT PANEL

FIGURE 2-1

SECTION 3

OPERATION

3.1 FRONT PANEL CONTROLS

The following controls are listed in order, from the top to the bottom of the panel. The controls relating to the memory are absent on the Model 1038-V10, as is indicated in their description. A photograph of the Model 1038-V11 front panel appears in Figure 2-1.

a. OFFSET dBm/dB and POLARITY SWITCHES. These controls permit the input signal to be offset to a null on the reference line. The amount and polarity of the offset required can be read from the digits on the OFFSET switch and the position of the polarity switch. The reading obtained is an indication of the difference (in dB) between the signal and the reference. For example, if the INPUT dBm button is used (0 dBm reference) and an offset of -12 dB nulls the signal, the signal level is just -12 dBm.

b. SMOOTH SWITCH. This switch reduces the bandwidth of the log amplifier on all dB/DIV sensitivity settings. Smoothing is effective when the switch is depressed. At low signal levels (below - 40 dBm) there are random variations in signal amplitude due to noise and some signal feed through from the input chopper circuit. Reducing the bandwidth of the log amplifier reduces the noise displayed at low signal levels. It also causes the response to be slower at low signal levels, so that the displayed amplitude will be incorrect if rapid variations are displayed at excessive sweep speeds. This may be checked by slowing the sweep and observing whether the shape of the display changes. The sweep used must be slow enough that this does not occur.

c. REFERENCE KNOB. This knob must be pushed firmly to engage the control. This feature is to avoid accidental mis-setting of the control after a reference has been established. The purpose of the control is to permit the setting of an arbitrary reference level when the INPUT dB button is depressed. For example, when making reflection measurements, it is desired to calibrate the system for total reflection. To do this, a signal corresponding to total reflection is displayed. The OFFSET control is set to 00.0 dB and the trace centered on the reference line using the REFERENCE control. Subsequent reflection measurements can be made using the OFFSET switches and the return loss read directly from them.

On units with memory, the OFFSET switches are set to 00.0 and the REFERENCE knob used to bring the trace on screen when the ACCESS MEMORY button is depressed. The trace can then be recorded by pressing the PRESS TO STORE button.

d. DISPLAY SELECTOR SWITCHES. There are two columns of display selector buttons. The switches on the left select what is to be displayed; those on the right select the sensitivity, or resolution, of the display (except when MEMORY is displayed). Individual switch functions are as follows:

i. INPUT dBm. Displays the input signal, with 0 dBm as the reference level.

ii. INPUT dB. Displays the input signal, with the reference level set by the REFERENCE knob.

iii. INPUT MINUS MEMORY. Appears on -V11 and -V12 plug-ins only. Displays the input signal with the contents of the memory subtracted (in dB). The dB reference is the signal recorded in the memory.

iv. MEMORY. Displays the contents of the memory. Since the memory records the sensitivity of the display (dB/DIV) at the time data is stored, the display of the memory contents will be at the sensitivity recorded. Therefore, the display will be unaffected by the dB/DIV button selected.

v. ACCESS MEMORY and PRESS TO STORE. These two buttons are electrically interlocked so that the PRESS TO STORE button is inoperative unless ACCESS MEMORY is depressed. When ACCESS MEMORY is pressed, the plug-in is set-up so that any part of the trace that is on the CRT screen can be recorded. Normally, the OFFSET switches should be returned to 00.0 and the trace moved on screen using the REFERENCE knob. The display sensitivity should be increased by selecting an appropriate dB/DIV setting so that the trace covers as much of the available vertical dimension as possible without having part of the trace off screen. Pressing PRESS TO STORE will then cause the trace to be recorded in the memory.

vi. dB/DIV. These switches select the sensitivity, or resolution, of the

display. The number adjacent to the switch indicates the scale for each major vertical division on the CRT.

e. REF LINE. This switch selects the major horizontal line on the CRT graticule that serves as the reference. That is, if a signal equal in magnitude to reference is applied to the input, it will lie on the line indicated by the pointer on the REF LINE switch. It is also the line about which the display expands as successively greater display sensitivities are selected.

f. HIGH LEVEL SCREWDRIVER ADJUSTMENT. This adjustment is used to calibrate the instrument at +10 dBm using the calibrator on the horizontal plug-in.

g. NOISE LEVEL SCREWDRIVER ADJUSTMENT. This adjustment is used to calibrate the instrument for zero signal input. With no RF applied, at 10 dB/DIV, +4 REF LINE, dBm, 00.0 OFFSET, and no smoothing, adjust so that noise is visible as the trace almost, but not quite, touches the noise-free bottom limit.

3.2 FRONT PANEL DETECTOR CONNECTOR

This multi-pin connector is keyed to prevent misalignment. Be sure that the key on the plug mates with the keyway on the panel connector before inserting. Various types of Pacific Measurements power detectors can be used and an adapter cable is available for use with detectors of other manufacture.

3.3 OPERATING PROCEDURE

The vertical plug-ins must be installed in either of the right-hand locations in the Model 1038 Mainframe, as described in Section 2.2. In order to generate a complete display, a horizontal plug-in is also needed. Horizontal plug-ins are all compatible with any of the Vertical plug-in Models 1038-V10, -V11, or -V12. However, in order for the memory to work in the -V11 or -V12 units, a horizontal plug-in with memory drive must be used in the horizontal location. Connection of a suitable detector to the DETECTOR INPUT of the vertical plug-in completes the system.

3.3.1 DETECTORS

RF Detectors supplied for use with the vertical plug-ins are equipped with RF connectors for connection to sources of RF power. Depending upon the connector type and the characteristics of the detector, the maximum frequency for the detector will be different, so be sure to check the specifications for the detector before using it at the highest RF frequencies. Each detector has slightly different detection characteristics from another. If a detector and an instrument are ordered together, the instrument will be calibrated with the detector it is shipped with and a label will be affixed to the instrument to identify the detector. If the instrument is used with other detectors you should expect slight tracking errors as RF power is varied over the range. These errors will be slight, in most cases limited to less than one half dB over the entire dynamic range. If you want to calibrate an instrument to a different detector, refer to the detector calibration procedure of Section 6.

An adapter cable is available for connecting detectors or devices with built-in detectors having BNC output connectors to the DETECTOR INPUT of the plug-in. The use of the special cable is recommended because it has a low-pass filter to isolate the cable from the RF signal and a temperature compensation sensor. While the temperature sensor is close to the BNC connector in the brass block to which the connector is mounted, you should nonetheless be careful to avoid subjecting it to sources of heat not affecting the detector to which it is connected. For example, sunlight coming in a window where the detector is in a shadow and the adapter is directly illuminated.

3.3.2 CALIBRATION CHECK

When the instrument is first set-up, its detector exchanged, the temperature of the room substantially changed, or you have any reason to question the calibration, use the following procedure.

a. High Level Calibration Check. Allow the instrument to warm-up for at least 10 minutes--longer if it has been stored in a cold place. Connect the detector to the CALIBRATOR OUTPUT on the horizontal plug-in, turn the CALIBRATOR switch to ON, and set the HORIZONTAL INPUT switch to INT. Set the OFFSET switch to +10.0, the REF LINE to center, and press the INPUT dBm and .1 dB/DIV buttons. The trace should be in the center of the screen; if necessary, adjust the HIGH LEVEL control with a small, narrow screwdriver to center the trace.

b. Noise Level Calibration Check. Connect the detector to the measurement system where it will be used. Allow the temperature to stabilize for 5 minutes. Turn the RF power off (be sure that it is completely off--not just attenuated 20 or 30 dB). Set the OFFSET switch to -40, the REF LINE to center, the SMOOTH button out, and press the dBm and 10 dB/DIV buttons. On the horizontal unit turn the CALIBRATOR to OFF and the input to INT. Adjust the NOISE LEVEL control so that the trace 'bottoms out' and the noise disappears into a straight line--then return the control until the noise is a maximum and the trace is just clear of the limiting line.

3.3.3 ABSOLUTE POWER DISPLAY

If power is to be displayed against another variable, typically frequency, connect the X-axis drive to the INPUT of the horizontal plug-in and adjust for a full-screen sweep. To obtain the display, connect the detector to the signal to be measured, set the OFFSET switches to -20 dB, SMOOTH button out, REF LINE to center, and press the INPUT dBm and 10 dB/DIV buttons. Having obtained a display set the REF LINE to the desired position. If smoothing is desired, or if you are going to use sensitivities greater than 5 dB/DIV, check to see that pushing SMOOTH does not change the shape of the picture. If it does, slow down the sweep until the effect is no longer noticed.

In order to see small variations in signal level across a band of frequencies, you will need to use greater display sensitivity (smaller number of dB/DIV). To do this you must move the portion of the display of interest to the reference line, using the OFFSET switches. The display is expanded using a more sensitive dB/DIV setting. The reading on the OFFSET switch is the power (in dBm) at the point where the trace crosses the reference line. Variations from that level can be read directly off the CRT graticule.

3.3.4 RELATIVE POWER DISPLAY

Set up a display according to the first paragraph of Section 3.3.3. Press the INPUT dB button and move the REFERENCE control until the trace is in the desired position. In general the REFERENCE control is set when the unit is displaying a calibration curve. For example, when making a transmission measurement the detector is first connected to the RF source and the trace centered on the reference line, with the OFFSET set to 00.0 dB. Then the device to be tested is inserted between the source and the detector. The resulting trace is the loss vs. frequency. By increasing the sensitivity to a small number of dB/DIV and moving the OFFSET control to center any desired portion of the trace on the reference line, the loss at that point can be read precisely from the OFFSET switch.

3.3.5 USE OF THE MEMORY

On units so equipped, the memory can be thought of as an extension of the relative power mode. The display is set up in the same way, except that the ACCESS MEMORY button is pressed prior to adjusting the REFERENCE control. The action of the memory is to reduce the calibration curve to a straight line lying on the reference line. The OFFSET switch is set to 00.0 and the trace centered on the screen using the REFERENCE control. The sensitivity is increased so that the calibration trace fills the screen but does not go beyond the screen. Now, when the PRESS TO STORE button is pressed, the trace will momentarily appear to be made up of dots, then return to its previous form. This indicates that the trace has been recorded in the memory. To check the contents of the memory, press the MEMORY button; you should see the same or nearly the same curve as the calibration trace. When INPUT MINUS MEMORY is pressed a straight line should result, as the calibration curve recorded is subtracted from the calibration curve from the input. When subsequent measurements are made on an RF device, the data displayed will be just the characteristics of the device, since the apparent calibration curve is just a straight line corresponding to the reference line. If the OFFSET switch is used, its dial will read the loss or gain of the device under test directly. It is important not to move the REFERENCE control after memorization as this will move the reference an unknown amount. The control knob disengages from the shaft unless it is pushed in, to avoid accidental movement.

SECTION 4

PERFORMANCE CHECKS

4.1 GENERAL

The purpose of this section is to provide a series of tests that will insure that the instrument is operating properly. It is useful for incoming inspection and for periodic performance evaluations. Major specifications are checked and other tests performed which would point out a malfunction within the unit.

4.2 EQUIPMENT REQUIRED

The following equipment is needed to check the performance of the Models 1038-V10, -V11, and -V12.

a. A properly calibrated Model 1038 Mainframe and Display Unit.

b. A properly calibrated horizontal plug-in. For the Models 1038-V11 or -V12, a horizontal unit with memory drive is required.

c. A precision, calibrated step attenuator or separate individual attenuators. Steps of 10 dB from 0 through 60 dB are required. Attenuators should be within 0.4 dB of the nominal value and their exact attenuation should be known to within 0.02 dB at 30 MHz.

d. A sweep signal source with a frequency band compatible with the detector, together with a low-pass filter with a cutoff frequency in the low end of the band. The purpose is to generate a display with considerable amplitude variation across the band.

4.3 INITIAL TURN-ON

Install the plug-ins in the Model 1038 Mainframe, connect the Model 1038 to a line of suitable voltage and frequency. Allow the instrument to warm up for at least one-half hour in a room with a temperature of 25°C ± 5°C. The detector with which the instrument was calibrated (as indicated by the label on the front panel) should be connected to the DETECTOR INPUT during this period.

4.4 POWER LEVEL TRACKING

a. Adjust the HIGH LEVEL and NOISE LEVEL controls according to the procedure of Section 3.3.2. The detector should be screwed on to the attenuator when adjusting the NOISE LEVEL control.

b. Connect the detector to the attenuator if a step attenuator is used and set the attenuator for 0 dB. Connect the input to the attenuator to the CALIBRATOR OUTPUT of the horizontal plug-in. If fixed attenuators are used, connect the detector directly to the CALIBRATOR OUTPUT. Set the OFFSET switch to read the insertion loss of the attenuator at the 0 dB setting for 30 MHz. Set to -00.0 if a fixed attenuator is used. Press the INPUT dB button and adjust the REFERENCE control so that the trace is on the center of the screen with the REF LINE switch set to center. It will be easiest to see the trace if the INT horizontal setting is used. Start at 10 dB/DIV and increase the sensitivity from there so that the final adjustment is at .1 dB/DIV.

c. Press the 10 dB/DIV button and check to see that the trace is within one-half of a minor graticule mark of the center. Using the REF LINE switch, set the trace on each of the major graticule divisions. It should lie within 1 minor division of the graticule line. Return the REF LINE switch to center.

d. Set the attenuation to 60 dB and set the OFFSET switch to 60 dB. Adjust the NOISE LEVEL control so that the trace crosses the screen an amount above or below the center corresponding to the correction factor for the attenuator. For example, if the correction factor indicates that the attenuation is less than nominal by 0.2dB, the trace should be 1 minor division above the center on the 1 dB/DIV range. Make the final adjustment on the 0.5dB/DIV range. There will be some noise on the trace and it will be necessary to average this out when making the final adjustment.

e. Return the attenuation to 0 and check that the trace is centered except for the insertion loss with the OFFSET set to 00.0.

f. Step the attenuation from 0 to 60 dB in 10 dB steps. Set the OFFSET switch to the same setting as the attenuator and check to see that the trace goes across the screen an amount above or below the center corresponding to the correction factor for the attenuation used, within 0.1 dB. This will be within one division on the .1 dB/DIV range.

4.5 MEMORY OPERATION (MODELS 1038-V11 and -V12 ONLY)

a. Connect the low-pass filter to the output of the sweep signal source. Connect the detector to the output of the low-pass filter. Set up a display showing the curve of the filter on 10 dB/DIV. Refer to Section 3.3.3 and

following for information about how this is done. When the set-up is complete you should have a trace starting near the upper left corner of the screen and ending near the lower right corner. The actual details of the appearance of the trace are not important if it covers most of the horizontal and vertical dimensions of the screen.

b. Press ACCESS MEMORY and be sure that the trace is all on-screen. Record the trace by pressing PRESS TO STORE. Press the MEMORY button and examine the display. The trace should be very similar to the display when ACCESS MEMORY was depressed. Now press INPUT MINUS MEMORY; the display should be very nearly a straight line.

c. Since the display was recorded on 10 dB/DIV, pressing the 1 dB/DIV button should expand the size of the vertical steps by ten. In the region of the filter response where there is considerable vertical movement, the display will appear as a series of diagonal lines. These lines should be about one-third of a division long, with some appearing to be twice that long. If this is the case, the memory can be considered to be working properly.

SECTION 5

CIRCUIT DESCRIPTION

5.1 INTRODUCTION

Figure 5-1 shows a block diagram of the basic amplifiers, logging and detector compensation circuits. Figure 5-2 shows a block diagram of the memory circuits, as used in the Models 1038-V11 and -V12. The block diagrams will be described first then the details within the blocks. For detailed descriptions of the blocks, reference will be made to the circuit diagrams. They will be found in Section 7.

5.2 DESCRIPTION OF THE BASIC CIRCUIT BLOCK DIAGRAM

Because of the extremely small signals measured by the detector and the resulting sensitivity of the circuits amplifying them it is necessary that no extraneous currents flow in the signal ground leads. For this reason the input amplifier circuits are isolated from the chassis ground. An oscillator-type power supply provides an isolated source of dc to power these circuits. A differential amplifier transmits the signal from the isolated portion of the circuit to the output circuits which are at chassis ground. The differential amplifier has a high input impedance for good isolation and high common-mode voltage rejection so that parasitic signals appearing on the bench ground to which the detector is attached will be ignored. We shall first consider the isolated portion of the circuit.

The RF Detector converts the RF power incident upon it to a dc voltage. This voltage is proportional to power at very low input levels and gradually becomes proportional to RF voltage at high input levels. The sensitivity at low levels and the point at which it starts to deviate from a power-law device are functions of the detector temperature. Accordingly, the detector temperature is monitored and appropriate corrections applied to the circuits following the detector. Three leads come from the detector: a common lead tied to the detector shell, a power sensing lead and a lead from a thermistor. The thermistor is in intimate thermal contact with the brass detector shell.

The thermistor bridge amplifier converts the high impedance signal from the thermistor to a low impedance signal which is very nearly proportional to temperature. The amplifier feeds the compensation circuits and the log amplifier so that the square-law compensation and sensitivity of the system will be correct, regardless of detector temperature.

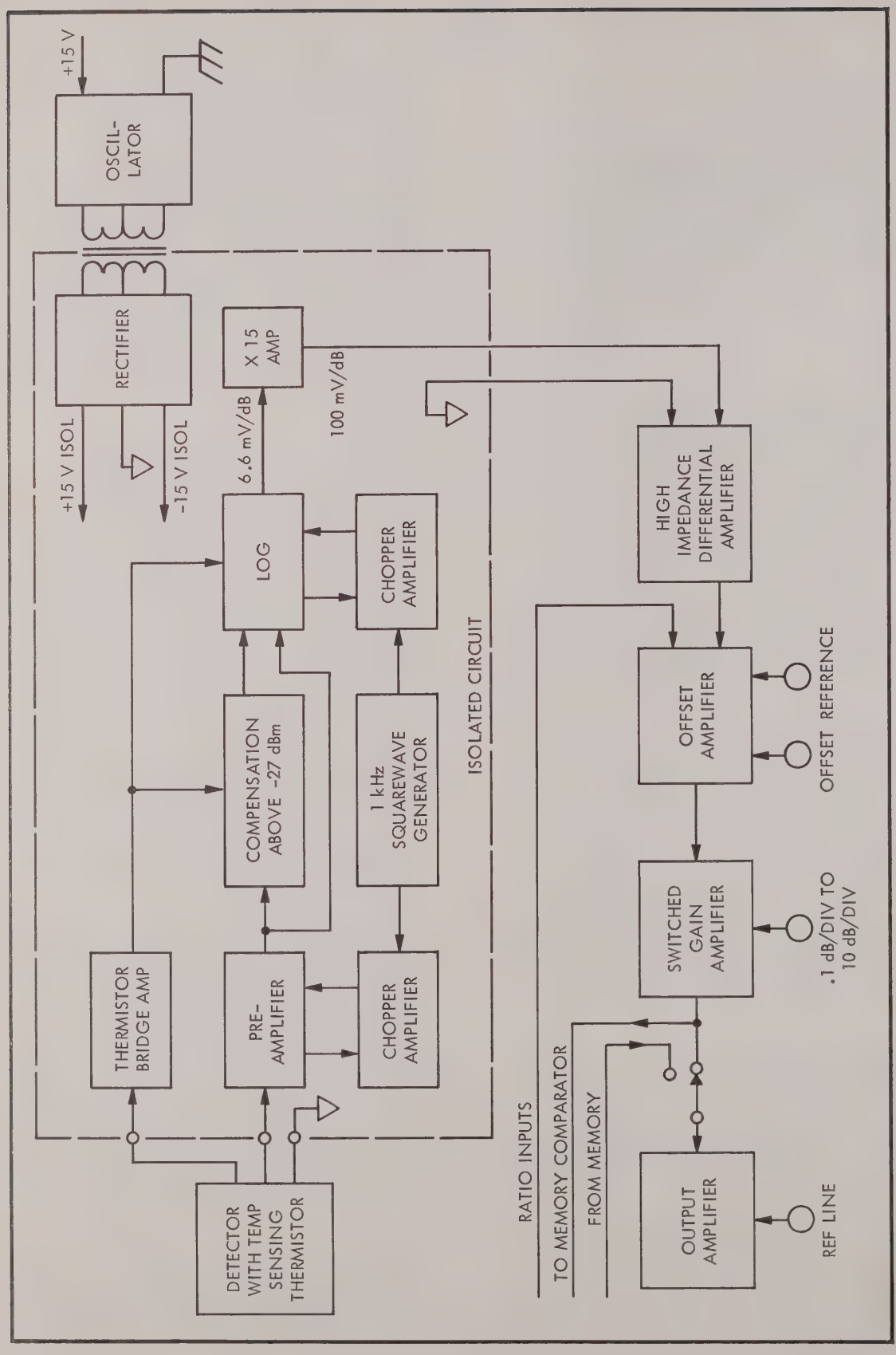
The pre-amplifier is a high input impedance, low noise amplifier. It is chopper stabilized to reduce drift to an absolute minimum. A one kHz relaxation oscillator drives both the input chopper stabilization amplifier and the one for the log amplifier. The pre-amplifier has a gain of 11. It feeds the log amplifier directly and indirectly through the compensation circuit.

The compensation circuit starts to become active for an RF input of approximately -27 dBm. At the output of the pre-amplifier this is about 15 mV. At this voltage level there is no need for chopper stabilization and none is provided. The compensation circuit generates a current proportional to the square of the input voltage. This current is summed in with the current from the pre-amplifier at the input to the log amplifier. As signal level increases and the detector output voltage departs from square-law, the amount of current from the compensation circuit increases so that the total current still corresponds to a square-law signal.

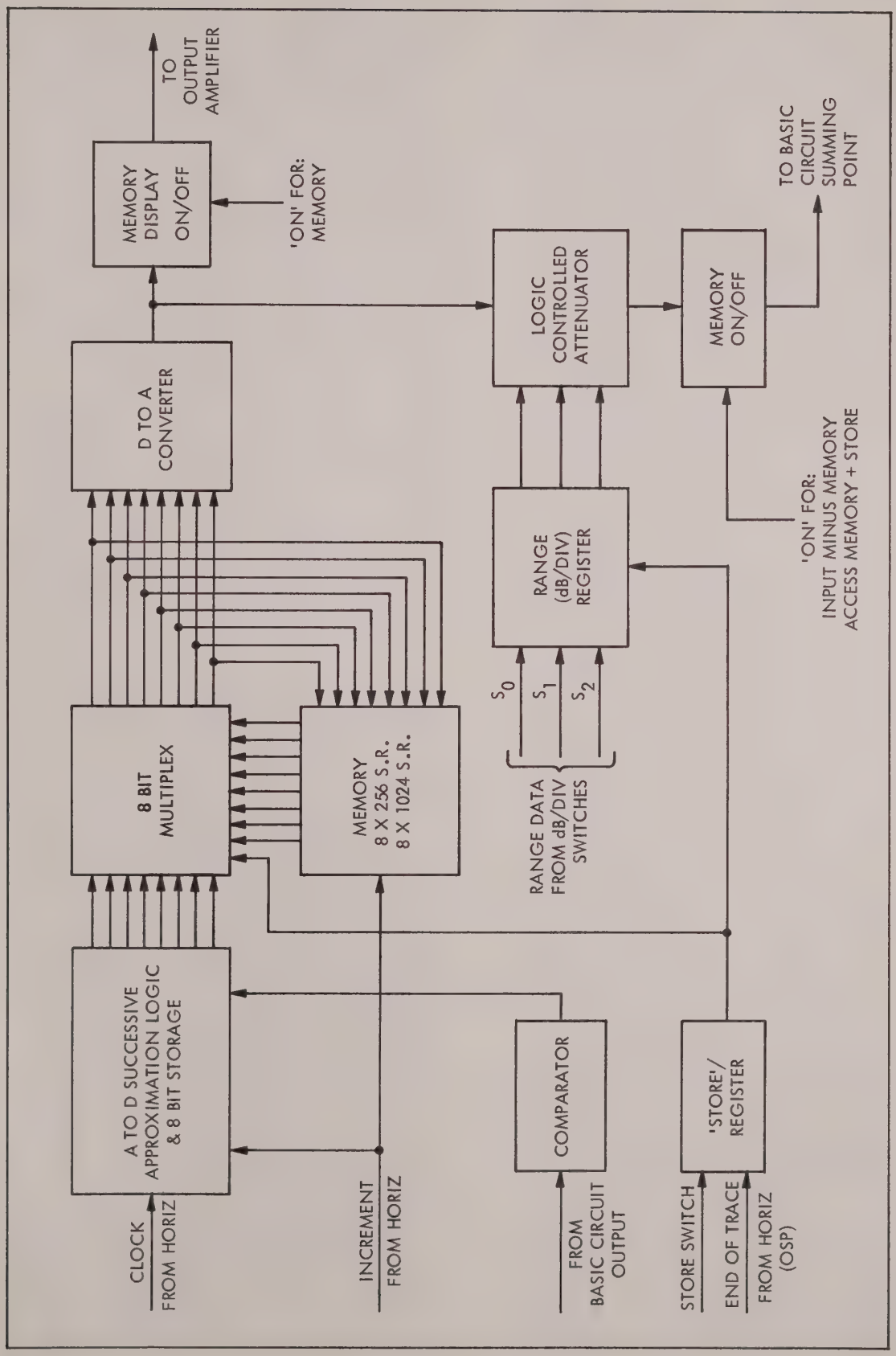
The logarithmic amplifier has a very wide dynamic range, from less than 100 μV to greater than an equivalent of 100 V. In order to be free of drift over this range it is chopper stabilized. A transistor is used as the logging element; its output is temperature dependent so it is placed in an oven. At the operating temperature, its output is 6.6 mV/dB. An amplifier follows the logging circuit. Its gain of 15 raises the level to 100 mV/dB. Critical parts of the compensation circuit are also temperature sensitive and, like the logging transistor, are located in the oven. The oven is electronically regulated to provide a constant 60°C environment. Its power comes from the supplies referenced to chassis ground but the components mounted in it are isolated. A small power supply oscillator runs at approximately 20 kHz to provide power to the isolated circuits through a transformer. The ac voltage at the secondary is rectified to give + and - 15 Vdc. Since the oscillator runs off a regulated voltage, the secondary voltage is independent of input line voltage.

A differential amplifier provides the means of transferring the signal from the isolated circuits to a ground-referenced signal. It has a high input impedance and good common-mode rejection. Parasitic signals appearing on the bench ground to which the detector is connected are rejected by this arrangement. Potential ground-loop currents are kept negligible because of the high impedance to ground seen by the isolated circuits. Following the differential amplifier is a summing amplifier providing a common point at which OFFSET and REFERENCE controls can supply currents corresponding to their setting. It is also at this point that ratio signals are inserted and correction signals from the memory (when applicable) are applied.

A switched-gain amplifier permits the selection of various scale factors (dB/DIV). Signals controlling its gain come from the front panel switches. They are TTL logic levels which are also used in the



BASIC CIRCUIT BLOCK DIAGRAM
FIGURE 5-1



MEMORY BLOCK DIAGRAM
FIGURE 5-2

memory. A final output amplifier has provision for offsetting the vertical position in one division increments by using the front panel REF LINE switch. Depending upon the display selected, the amplifier either connects to signal from the switched gain amplifier or a signal direct from the memory circuit.

5.3 DESCRIPTION OF MEMORY BLOCK DIAGRAM

The circuit in the horizontal plug-in supplies signals telling the memory circuit: (1) It is time to take a new reading or supply new data; this line is named "Increment". (2) That the end of the horizontal sweep has occurred. This is the "Overspill" line. (3) Basic time information on the "clock" line. This information permits the memory to record and play back data in synchronism with the horizontal sweep.

During the record cycle the analog-to-digital converter generates a digital word corresponding to the negative of the analog data displayed prior to recording. This is accomplished by a successive-approximation-type D to A converter. The 8 bit binary word generated by the D to A converter goes to the input of a shift register where it is stored.

To cause the data to be recorded, the ACCESS MEMORY button is depressed and the STORE switch momentarily pressed. This causes the "Record" register flip-flop to raise the "Record" line, starting at the end of one sweep and continuing during the next sweep, then returning to a low condition at the end of that sweep. Thus, the recording process occurs for the duration of exactly one sweep.

The resolution of the memory is 1/256 of the CRT screen for the range displayed. For example, if the sensitivity is set to 0.5 dB/DIV, the full screen covers 4 dB and the size of each step from the memory is 4/256 or .0156 dB. For other sensitivity settings the size of each step would be correspondingly greater or less. Since the display sensitivity can be changed after the trace is recorded, it is required to record the sensitivity setting used at the time the trace is recorded and to attenuate the signal from the D to A converter in accordance with the range setting used during the record cycle. This is accomplished by the Range Register and Logic-Controlled Attenuator. During the record cycle or when INPUT MINUS MEMORY is selected, corrections from the memory are applied through the Logic Controlled Attenuator to the Basic Circuit Summing Point. When MEMORY is displayed, the output of the D to A feeds the vertical output of the plug-in directly. The result is that the memory display always appears the way the trace did at the time of recording.

The D to A converter has two modes of operation. (1) During the record cycle it acts as a component of the successive approximation A to D converter. The 8 bit multiplexer connects it to the successive approximation logic. After the approximation has been completed for a given correction point, the data feeding the D to A converter is equivalent to the value of the voltage driving the CRT. The memory input is also connected to the D to A, so that when the next Increment pulse arrives the word driving the D to A will shift into the register. (2) When recording is complete, the output of the Record register drops and the 8 bit multiplexer connects the D to A to the output of the memory. The D to A converter now generates a correction voltage corresponding to the contents of the memory. In addition, the output of the memory is now connected back to its input through the multiplexer and the stored data recirculates so it is retained in the register.

The A to D logic obtains timing information from the clock. It initiates a new conversion each time it receives an Increment pulse from the horizontal circuit. In operation it successively "tries" current corresponding to the most significant through the least significant bits of the 8 bit word. As each current is tried, the comparator determines whether or not its contribution exceeds the current corresponding to the CRT display. If not, a "1" is placed in the 8 bit storage register and the current for that bit remains. If it is excessive, a "0" goes into the register and the current for that bit is dropped. When the process is complete the sum of all the currents will be just equal to the input current within 1 bit, or 1/256 of 8 divisions.

5.4 BASIC CIRCUIT BLOCK DESCRIPTIONS

The following detailed descriptions refer to the circuit schematic diagrams in Section 7.

5.4.1 INPUT PRE-AMPLIFIER

The input signal divides into two paths, the ac portion going directly to U15 and the dc portion going by way of the chopper amplifier. Feedback is by way of R197 and R183 which form an 11.3:1 voltage divider. AC signals are coupled to U15 by C79 with the feedback signal coupling through C78. The chopper, Q29 and Q30 converts any difference voltage between the feedback divider and the input to an ac signal at the drive frequency of 1 kHz. A transformer, T2 transmits this ac signal to U13. U13 is connected together with a Twin-Tee network to form a narrow-band active filter with a center-frequency gain of about 3,500. The full-wave balanced demodulator, U14 detects the signal and its output at R161 supplies correction signals to U15 so that the voltage at the feedback divider will be exactly equal to the input voltage at dc and very low ac frequencies. At higher frequencies, the action of U15 itself assures equality.

Both the chopper and the demodulator require two separate out-of-phase signals. They are generated by a Schmitt Trigger consisting of Q32 and Q33 with Q34 supplying a constant current. Since a constant current is supplied to the common emitters, whichever transistor is on will have the same collector

current as the other when it is on. This results in identical, but out-of-phase, square waves appearing across the equal collector load resistors. Q35 supplies a constant current required by the demodulator IC. To make the circuit oscillate, Q31 supplies current to the capacitor C77 when Q33 is on. When the voltage on the capacitor exceeds the common-emitter potential by a few hundred millivolts Q32 turns on and positive feedback to the base of Q33 turns it off. This also turns Q31 off and the voltage on the capacitor decays until it is a few hundred millivolts above the new (and lower) potential of the common emitters. At this point Q33 begins to conduct and positive feedback turns it all the way on so that Q32 is off. This once again turns Q31 on and the process repeats. The output voltages also drive the choppers and demodulator for the log amplifier.

5.4.2 LOG CONVERSION CIRCUIT

The log conversion circuit is a high gain operational amplifier with feedback from the collector of a transistor. The emitter-base voltage is proportional to the log of the collector current over many decades of current values. The logging transistor is located in an oven operating at 60°C; at this temperature the emitter-base voltage changes by 66.5 mV for each factor of ten that the collector current changes. Since a factor of 10 represents 10 dB, this is 6.65 mV per dB. An amplifier follows the log transistor with a gain of 15, raising the level to 100 mV/dB.

The operational amplifier part of the log conversion circuit is chopper stabilized in much the same way as the pre-amplifier. Since the sensitivity is not so great the circuit is simpler. The integrated amplifier, U10 receives ac input directly through C45, dc signals are routed through the chopper amplifier and go to pin 3 of U10. The current summing junction is common to the chopper input and C45 with a voltage monitoring test point, J7 connected through an isolating resistor R74. If at any time the summing junction is not at zero dc potential, the chopper switching transistors, Q16 and Q17, will convert this potential to an ac signal. The ac amplifier, U9, amplifies the signal and supplies it to the synchronous demodulator, Q22 where it is converted to dc. A low pass filter, R107 and C44, removes the ac component and the dc correction signal goes to pin 3 of U10, causing its output to change the current through the logging transistor bringing the summing junction back to zero. The 1 kHz drive for the chopper comes from the circuit driving the input chopper.

It is required to reduce the noise present on the display for low signal levels and when viewing the signal at high sensitivity (e.g., 0.1 dB/DIV). To accomplish this, Q25 connects a capacitor, C50, in the feedback path. The optical coupler, Q26, permits ground-referenced signals to control whether Q25 is on or off.

Integrated amplifier U11 provides the gain of 15 required to raise the signal level to 100 mV/dB. It also offsets the signal so that zero volts output represents approximately -20 dBm.

5.4.3 SQUARE-LAW COMPENSATION CIRCUIT

Above -27 dBm the square-law compensation circuit generates a current proportional to the square of the input signal to compensate for the detector's becoming linear rather than square-law at high input power. Q18 and U7 form a high input impedance operational amplifier. Feedback through Q19 results in the emitter-base potential of Q19 being proportional to the log of the input signal in the same way as for the log conversion circuit. Operational amplifier U8 has a gain of very nearly 2 and its output drives the emitter of another transistor, Q21, to generate an exponential current. The mathematical effect of the arrangement is to take the log, multiply by 2 then take the anti-log--simply resulting in squaring the input signal. Since the characteristics of the transistors are temperature dependent, they are located in the oven.

The output current from Q21 is summed at the input to the log conversion circuit along with the direct signal from the pre-amplifier. The direct signal is dominant at low levels with the compensation signal becoming most important at high levels.

To provide temperature compensation for the detector U12 acts as a bridge amplifier for the thermistor located in the detector mount. R130 is a resistor whose value was selected to linearize the thermistor output over the range 0 to 50°C. The output at pin 6 changes approximately 2.5 mV/°C. Correction signals from U12 go to U8 to compensate the shape of the square-law compensation and to U11 to correct the absolute calibration.

5.4.4 OFFSET CIRCUIT

The offset circuit is referenced to chassis ground. Differential amplifier U1 has its inputs connected to the output of the log conversion circuit and the isolated signal common. Since it has good common mode rejection, only the signal between the log conversion circuit's output and isolated common will be amplified. The differential amplifier has a gain of unity. Its output feeds the offset summing junction through R7 and R6. R6 is adjusted to match the current steps from the OFFSET switch which is 10 μA/dB.

Several other signals are applied to the summing junction. Each input independently moves the trace an amount corresponding to the current applied. The inputs are: (1) HIGH LEVEL cal, (2) The four ratio inputs, (3) The OFFSET switch current, (4) The dBm calibration adjustment, (5) A resistive divider R13 and R14 to cause 0 dBm to be the reference when dBm is depressed, and (6) The output of the REFERENCE control through R13 when dBm is not depressed. Integrated amplifier U2 amplifies the currents at the

junction and converts the sum to voltage.

5.4.5 SENSITIVITY CONTROL CIRCUIT

The integrated amplifier U3 has its input and feedback circuits controlled by logic signals derived from the front panel dB/DIV switches. Its output swing is limited by the action of Q6 and Q7 so that its recovery time following an overload will be short. The four gates of U5 are connected to generate a three bit logic code convenient for the control of the FET switches which determine the gain of the circuit. The basic gain of the circuit is one-half and gives 1 dB/DIV. Q4 increases the gain by a factor of 2 when active (on the .5, .1, and 5 dB/DIV ranges). Q3 increases the gain by an additional factor of 5 on the 0.1 dB/DIV range. Q5 reduces the feedback resistor by a factor of ten resulting in an equivalent gain reduction on the 5 and 10 dB/DIV ranges. The signal from U3 goes to U4 for output to the display, except when MEMORY is selected for display, in which case Q8 is opened and the input to U4 is on pin 2 from the memory. The REF LINE position current feeds pin 2 of U4 also, except that the front panel switches disconnect it for MEMORY or ACCESS MEMORY.

5.4.6 ISOLATED POWER SUPPLY

Power to run the isolated circuits comes from an oscillator-type power supply. Q14 and Q15 obtain positive feedback base drive from T1. The action of T1 is to supply base current to whichever transistor is turned on until the transformer saturates. At the saturation point the base-drive winding is effectively uncoupled from the primary. Without base drive, the previously conducting transistor stops conducting so the primary current drops, allowing the magnetic field to start to collapse. The collapsing magnetic field induces a voltage of the opposite polarity in the base-drive winding causing the previously nonconducting transistor to switch on. This new state continues until the transformer is saturated in the new direction, then the process repeats. The frequency of operation is about 20 kHz.

A bridge rectifier supplies dc from the secondary to the isolated circuits. Voltage breakdown diodes CR7 and CR8 provide precisely regulated sources of + and -6.2 V to critical points. RC filter networks remove ac ripple and spikes on the secondary side and an LC filter keeps ac currents from disturbing the +15 V primary supply.

5.4.7 OVEN CONTROLLER

The oven controller maintains the temperature of the oven at 60°C. At that temperature the thermistor in the oven resistance has changed from its 25°C value of 100 kΩ to a value equal to R56, or 23.7 kΩ. At this value the two inputs to the amplifier, U6, are equal. If the oven cools slightly, the value of the thermistor increases causing the output of the amplifier to move positive increasing the current through Q12 and Q13. This causes Q13 to generate more heat, returning the oven to the proper temperature so that the thermistor circuit is once more in balance. At equilibrium, the circuit is just slightly off balance and the transistor supplies just enough heat to account for the heat loss to the surroundings.

5.5 MEMORY CIRCUIT BLOCK DESCRIPTIONS

The following material relates to those units equipped with memory. The memory block diagram is shown in Figure 5-2 and the schematic diagrams are found in Section 7.

5.5.1 "STORE" REGISTER

When ACCESS MEMORY is depressed, pressing the STORE button causes a logic low to appear at pin 1 of U9A. U9A and U9B are connected as an R-S latch, so pin 3 of U9A moves to a logic high and stays until it is reset. This means that a logic "1" appears at the D input of U8B. Since the T input of U8B connects to 0SP, which goes positive at the end of the sweep, the "1" transfers to the Q output at that time ($\overline{Q}$ goes to a "0"). U9A and U9B reset from $\overline{Q}$, placing a "0" at the D input of U8B. At the end of the next sweep T once again goes positive transferring the "0" at D to Q. The net result of this is to cause the Q output of U8B to rise at the end of the sweep following the pressing of the STORE button and to remain up during the next sweep, then to fall at the end of that sweep. This signals that recording is in process. This signal is designated "LOAD".

5.5.2 dB/DIV REGISTER AND LOGIC-CONTROLLED ATTENUATOR

Latches U7A, U7B and U8A store the dB/DIV functions S_0, S_1, and S_2 which come from U5 of A2 (see Section 5.4.5). The data at the D inputs of the latches are transferred when LOAD goes up at the beginning of the recording process and it remains at the outputs of the latches until another recording is made. The latches drive the Logic-Controlled Attenuator.

In the logic controlled attenuator, transistors Q4 through Q7 operate FET switches which change the attenuation. Minimum attenuation occurs when Q11 and Q12 are on and all other switches are off; this happens on the 10 dB/DIV setting. Attenuation increases by a factor of 2 when Q13 goes on and Q12 is off; this happens on the 5 dB/DIV, .5 dB/DIV and .1 dB/DIV settings. Attenuation increases by a factor of 10 when Q14 turns on; this happens on ranges more sensitive than 5 or 10 dB/DIV. Attenuation increases by an additional factor of 5 when Q11 opens on the .1 dB/DIV range. Each attenuation factor is independent of the others and more than

one part of the attenuator may be in use at any one time.

A similar drive circuit controls Q10. When Q10 is on, the signal from the attenuator is connected to the offset summing point on A2, and corrections from the memory are effective. Q10 is on when in the MEMORY, INPUT MINUS MEMORY modes, or when recording. U9D, U9C and U3B are connected to make a 3 input NAND gate whose output is positive for the three conditions when Q10 should be on. In the MEMORY display mode, Q15 is turned on by Q9 to send a signal directly to A2U4. In addition the function "control A" is generated by Q16 to disconnect the other signals to A2U4.

5.5.3 DIGITAL-TO-ANALOG CONVERTER AND MULTIPLEXER

Digital signals coming from the multiplexer drive the D to A converter (DAC). Resistors with binary-weighted values supply currents to diode pairs in the DAC. One of the diodes is an ordinary computer diode connecting to the output of the multiplexer. If the output of a bit of the multiplexer is low, the current will flow through this diode and none will flow through the other diode. The other diode is part of an integrated circuit for the most significant bits (where things are most critical). When a bit is high, current flows through this diode to the input of an operational amplifier, U23. One of the diodes in the integrated circuit U22 provides temperature compensation. It connects to pin 3 of U23 causing this point to move (and pin 2 also by the action of U23) with temperature.

Pin 2 moves just enough to allow for the changes in the diodes connecting the resistors to the summing point, so that the voltage across the resistors remains constant. The result of this arrangement will be that there are common-mode voltage changes affecting pin 6 and pin 3 of U23 equally. Differential amplifier U24 discriminates against these and supplies a dc offsetting signal so that the output of U24 goes from -3.98 V to +3.98 V depending upon the digital word at the input of the DAC.

The multiplexer has two inputs, one coming from the analog-to-digital successive approximation logic and the other coming from the memory. During the record cycle the "LOAD" signal is up and the multiplexing circuits, U20 and U21 feed signals from the approximation logic to the DAC; otherwise "LOAD" is low and the memory feeds the DAC.

5.5.4 MEMORY

Depending upon whether the 256 point or the 1024 point memory is installed and the specific manufacturer of the memory integrated circuits the memory will differ slightly. The basic operation is similar in all cases. The input to the memory always sees the same signal as the DAC; this data is shifted into the memory each time an increment pulse comes from the horizontal plug-in for the 1024 point units and on every fourth pulse for the 256 point units. During the record cycle this data originates with the approximation logic, whereas at other times it comes from the memory itself. Thus, new data appears for the memory during recording and old data is recirculated at all other times, thereby retaining it in the memory. Some of the memories have an internal recirculate feature and use is made of this in some units. The counter in the horizontal unit is a 10 bit device, having exactly 1024 states, so it is synchronous with the registers in the vertical units.

5.5.5 SUCCESSIVE APPROXIMATION LOGIC AND COMPARATOR

The approximation logic sequentially "tries" the currents for each bit of the DAC and stores the data generated by the comparator after the circuit has had time to settle. The comparator connects to the output of the amplifier A2U3 (see Section 5.4.5); if the output is positive the comparator generates a logic "0", if negative a "1".

To start the process, an "Increment" (INC) pulse comes from the horizontal plug-in. It resets the counter, U1, and clears the 8 bit addressable latch, U2. It also allows the delayed clock to advance the shift register, moving the last data into the register. Clock pulses are supplied every 3 µs to the counter and the INC pulse is synchronous with the clock, so that there will be a clock pulse negative transition just 3 µs after the termination of INC. The counter thus starts at state 0, remains there for 3 µs, then increments to state 1 for 3 µs, continuing in this way to state 7. When state 8 is reached the "8" output of the counter goes high, driving the 9 reset input and causing the counter to abruptly go to 9 and hold.

The outputs from the counter go to the address inputs of U2, which permits data at the "D" input to control the state of the latch whose address is called by the counter. When the "8" output goes high, this information goes to the "disable" input of U2 by way of U4D and all data that has been entered will be held until the next INC pulse.

Immediately after the negative transition of the clock pulse, the D input of U2 is supplied with a logic "1". This lasts for about 2.5 µs, until the positive transition of the next clock pulse. At this point, the clock goes positive at pin 13 of U6D, allowing pin 12 to take control. In addition, a "1" is supplied to U6A, allowing the flip-flop comprised of U6A and U6B to be set to a "1" at U6B pin 6 if a "0" is supplied from the comparator, U5. If a "1" is supplied by the comparator, the output of U6B will remain a "0". The data at U6B pin 6 goes to pin 12 of U6D thence to the D input of U2. The result of this sequence is to cause the particular output of U2 which has its address supplied by the counter to go to a "1" during the first 2.5 µs of the clock period,

then to a state dependent upon the data at the comparator output.

The effect of this, in turn, is to cause the DAC voltage to go to the level corresponding to a "1" for that particular bit, then to either remain at that level or to drop back to the level corresponding to a "0", depending upon whether or not the input voltage to the comparator is positive or negative.

In order for data to remain in the latch, it is required to hold the Disable input high during the time when the address information is changing. Since the address information changes at the negative transition of the clock, a signal which is, in effect, a delayed clock pulse is needed. The circuit of U3E, Q3, and U4B supplies a delayed (and inverted) clock pulse to U4D, thence to the Disable input of U2. Since the rising edge of this pulse occurs before the trailing edge of INC and its trailing edge follows the trailing edge of INC, it is also useful to use this pulse to cause the shift register to shift just prior to the clearing of U2, while the data at U2's outputs is still valid.

SECTION 6

MAINTENANCE

6.1 PERIODIC MAINTENANCE

The following maintenance should be performed once a year unless the instrument is operated in an extremely dirty or chemically contaminated environment or is subjected to severe abuse. In such cases, more frequent maintenance is indicated.

a. Blow out all accumulated dust with forced air under moderate pressure.

b. Inspect the instrument for loose wires and damaged components. Check to see that all wire lead connectors are properly seated on their PC board pins.

c. Make a performance check in accordance with the procedure of Section 4. If the performance is within specifications no further service is required.

6.2 INTERNAL ADJUSTMENTS AND TEST POINTS

The following is a list of adjustments and test points supplied for ready reference. Do not attempt to make any adjustment until you have carefully read the material in Section 6.3.

6.2.1 DESCRIPTION OF ADJUSTMENTS

The function of each adjustment is described below.

a. A2C88, CHOPPER COMPENSATION. Used to balance the capacity of the two FETs used in the pre-amplifier chopper. Adjust for correct phase at TP211.

b. A2R6, OFFSET CAL. Used to adjust the signal from the log amplifier so that it matches the current from the OFFSET switch.

c. A2R21, 0 dBm CAL. Used to set the absolute calibration of the instrument with the front panel HIGH LEVEL adjustment centered.

d. A2R28, OUTPUT ZERO. Used to center the trace for 10 dB/DIV.

e. A2R79, SECOND STAGE INPUT NULL. Used to set the voltage measured at TP207 to 0 V within 10 μV.

f. A2R85, -27 dBm CALIBRATION ADJUSTMENT. Used to adjust the compensation amplifier so that it just becomes active at -27 dBm RF input.

g. A2R89, MEDIUM LEVEL CALIBRATION ADJUSTMENT. Used to adjust the compensation circuit for correct amplitude tracking at RF input levels near 0 dBm.

h. A2R94, MAXIMUM LEVEL CALIBRATION ADJUSTMENT. Used to adjust the compensation circuit for correct amplitude tracking at RF input levels near +10 dBm.

i. A2R163, PRE-AMPLIFIER CHOPPER BALANCE. Used to adjust the pre-amplifier for minimum chopper frequency noise signal.

j. A2R181, PRE-AMPLIFIER COARSE ZERO. Used to adjust the pre-amplifier for zero output voltage with no RF power applied to the detector and the NOISE LEVEL control centered in its range.

k. A2R186, FREQUENCY RESPONSE. Used to set the pre-amplifier for minimum settling time when the input RF signal is changed abruptly from +10 dBm to -50 dBm.

l. A3R8, MEMORY ZERO. (Units with memory only.) Used to set the memory so that the recorded reference line is displayed on the line set by the REF LINE switch.

m. A4R1 (or A2R72 on units with code 17 or higher) +10 dBm COMPENSATION. Use to correct amplitude tracking at +10 dBm.

6.2.2 DESCRIPTION OF TEST POINTS

The signal available at each test point or its function is described below.

a. A2J1 (TP201), +5 Vdc LOGIC SUPPLY. Measure between TP201 and Ground, TP203. Voltage should be +5 V ±0.2 V. Can also be used to power a logic probe.

b. A2J2 (TP202), OFFSET AMPLIFIER OUTPUT. Used to monitor the operation of the circuits ahead of the offset amplifier. Voltage coefficient should be 100 mV/dB within about one percent.

c. A2J3 (TP203), GROUND. Used as a reference point for measurements on the grounded portions of the circuit.

d. A2J4 (TP204), OVEN CURRENT MONITOR POINT. The oven current can be measured here by subtracting the test point voltage from 15 V and dividing by 11 ohms.

NOTE: THE FOLLOWING TEST POINTS ARE MEASURED WITH RESPECT TO THE FLOATING COMMON, TP209.

e. A2J5 (TP205), +15 Vdc ISOLATED SUPPLY. Nominal 15 V supply, actual voltage will be between 14.4 to 14.8 Vdc.

f. A2J6 (TP206), -15 Vdc ISOLATED SUPPLY. Nominal -15 V supply, actual voltage will be between -14.4 and -14.8 Vdc.

g. A2J7 (TP207), SECOND STAGE SUMMING JUNCTION. Measure with a sensitive voltmeter. Set A2R79 so that the voltage is within 10 µV of zero.

h. A2J8 (TP208), COMPENSATION AMPLIFIER FIRST STAGE OUTPUT. Used to monitor the operation of the compensation amplifier, particularly when adjusting A2R85. Adjust so that the polarity of the voltage measured changes as the RF input signal goes through -27 dBm.

i. A2J9 (TP209), INPUT CIRCUIT FLOATING COMMON.

j. A2J10 (TP210), CHOPPER FREQUENCY. Use a frequency counter with a high input impedance. The frequency should be 1 kHz within 30 Hz.

k. A2J11 (TP211), CHOPPER DEMODULATOR INPUT. Used to monitor the action of the pre-amplifier chopper circuit when setting A2C88. Monitor with an oscilloscope and set for minimum signal and spikes lying at the zero-crossing points on the sinewave.

l. A2J13 (TP213), PRE-AMPLIFIER OUTPUT. Measure with a sensitive voltmeter. With no RF signal applied to the detector adjust A2R181 for 0 Vdc within 10 µV. The NOISE LEVEL control should be centered when this is done.

NOTE: THE FOLLOWING TEST POINTS ONLY APPEAR ON UNITS WITH MEMORY. MEASURE WITH RESPECT TO TP34.

m. A3J1 (TP31), +5 Vdc LOGIC SUPPLY. Measure between TP31 and logic ground TP34. Voltage should be +5 V ±0.2 V. Can also be used to power a logic probe.

n. A3J2 (TP32), INCREMENT PULSE (INC). A pulse appears here each time the memory address is incremented. Useful to trigger a monitor scope.

o. A3J3 (TP33), COMPARATOR OUTPUT. Used to monitor the action of the voltage comparator in the analog to digital converter.

p. A3J4 (TP34), LOGIC GROUND.

q. A3J5 (TP35), -9 or -12 Vdc SUPPLY. Depending upon the type of memory integrated circuits used the voltage will be either -9 Vdc within 0.2 V or -12 Vdc within 0.2 V.

r. A3J6 (TP36), DIGITAL TO ANALOG CONVERTER OUTPUT. Used to monitor the action of the digital to analog converter. Depending upon the digital word at the input to the D to A converter, the voltage will be between the limits of -4 and +4 V.

6.3 CALIBRATION

6.3.1 EQUIPMENT REQUIRED FOR CALIBRATION

The following equipment is required in order to perform the calibration procedure.

a. Pacific Measurements Model 1038 Mainframe and Display. The display section can be of any type supplied with the Mainframe. It is important that the Unit be correctly calibrated, as its calibration affects that of the plug-in to be tested.

b. Pacific Measurements Power Detector Cable, Part No. 12868.

c. Pacific Measurements Model 1038, Horizontal Plug-In. For calibrating units with memory, the Horizontal Plug-In must have memory drive capability. The calibrator should put out 10 mW, if you are calibrating with a detector, step o. It is important that the Horizontal Plug-In be properly calibrated before using it as part of the calibration set-up for the Vertical Plug-In.

d. An oscilloscope with 5 mV/Division sensitivity and at least 100 kHz bandwidth.

e. A Digital Voltmeter with 5-1/2 digit resolution and 1 µV per digit resolution. For example, Data Precision Model 2540A1.

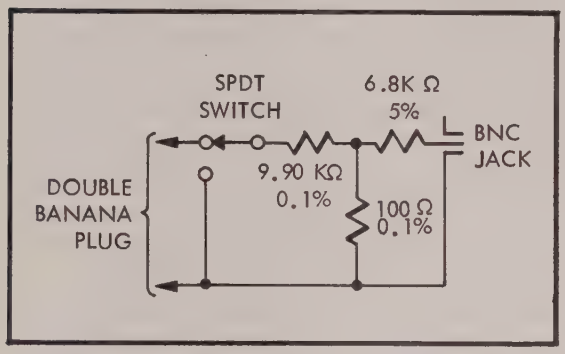
f. A Precision Power Supply with 10 µV resolution in the range from 1 mV to 1 V. For example, John Fluke Model 382A Voltage/Current Calibrator.

g. An attenuator made up of resistors as shown in Figure 6-1. The circuit can be conveniently constructed in a small phenolic box such as Pomona Electronics Model 2098. The box is equipped with banana plugs and jacks; since the output will connect to a BNC plug, a Double Banana to BNC adapter will be needed.

h. This item is required for calibration of units with memory. A Low Frequency Function Generator capable of generating a ramp going from 0 to 10 V into 50 kilohms. The

time to go from 0 to 10 V should be capable of being set to 40 ms.

i. An electronic counter capable of measuring 1 kHz. Input impedance 1 MΩ shunted by less than 100 pF.



ATTENUATOR USED FOR CALIBRATION

FIGURE 6-1

The following items will be needed if the calibration is to be checked with an RF detector. This calibration will normally be performed if the specific RF detector with which it will normally be used is available.

j. The RF detector with which the instrument will be used. Normally this will be the Pacific Measurements detector supplied with the instrument.

k. A precision attenuator calibrated at 30 MHz. If a step attenuator is used it should have steps of 10 dB from 0 to 60 dB. Individual attenuators can be used with some sacrifice in convenience. The actual attenuation should be known to better than 0.02 dB at 30 MHz.

6.3.2 CALIBRATION PROCEDURE

The components used in this instrument are extremely reliable and generate little heat. Consequently there is little drift due to component aging, and adjustments are rarely required. We therefore strongly recommend that if measurements indicate that an adjustment is set within the stated range, that you do not attempt to put it "right on". It is often the case that variations in the equipment used to test the instrument account for small differences in measured values. Other adjustments dependent upon a given adjustment will be affected if it is reset. In short, BE ABSOLUTELY SURE THAT AN ADJUSTMENT IS REALLY REQUIRED BEFORE MAKING IT.

If a component is replaced, depending upon where in the circuit it is located, only certain of the calibration steps need be performed. In general, only those steps shown in the section pertaining to the specific circuit repaired need be carried out.

It will be most convenient to gain access to the adjustments by placing the plug-in on an extender cable. Such a cable can be ordered from Pacific Measurements, Part No. 12715, Extender Cable Kit. Alternatively, place the plug-in in the middle plug-in location of the Mainframe and remove the side cover from the Mainframe/Display unit. It will be necessary to move the plug-in to the right-hand location to perform step 1.

Set the horizontal plug-in to display the channel into which the vertical unit to be calibrated is connected. This will be A or B; do not use the A/B, B/A, A/REF, or B/REF. Be sure the unused channel is OFF to avoid a confusing display. Select INT operation and turn the CALIBRATOR OFF.

The steps listed below must be carried out in the order listed. It will be helpful for you to read the entire procedure once through before starting. Allow at least one-half hour warm-up before starting. If the code number of your unit is code 02 thru 15 with suffix "B" or code 16 start the procedure by setting A4R1 full CCW. If your unit is code 17 or higher set A2R72 full CCW.

a. Check the + and - 15 V isolated supplies. Measure between TP205 and TP209 then between TP206 and TP209. The magnitude of the voltage should be between 14.4 and 14.8 V. If the voltage does not fall between these limits, trouble is indicated.

b. Check the operation of the oven regulator. Measure between TP204 and TP203. The voltage should be approximately -13.7 V immediately after turn-on, dropping to about -14.7 V after 1 to 5 minutes (depending upon the ambient temperature and how long the oven has been turned off). Operation markedly different from the above is an indication of trouble with the oven circuit.

c. Using the electronic counter, measure the frequency at TP210 with the common lead of the counter connected to TP209. The frequency should be 1 kHz within 30 Hz. If not, A2R166 can be changed to correct it.

d. Connect the Power Detector Cable to the DETECTOR INPUT and connect the BNC end of the cable to the attenuator described in Section 6.3.1 g. Turn the switch on the attenuator to the 'off' position. Set the attenuator and detector cable assembly on an insulated surface not connected to ground. Connect the input of the oscilloscope to TP211 and the ground lead of the oscilloscope to TP209. Be sure that the oscilloscope and the Model 1038 both have their chassis grounded through the 3 prong power cords.

Connect a trigger input lead from the external trigger connection of the oscilloscope to TP210, set the sweep to 0.5 ms/DIV and adjust the trigger level control on the scope to obtain a stable display. Set the input sensitivity to 5 or 10 mV/DIV as desired.

Adjust A2C88 (use an insulated tool) to obtain the minimum signal viewed by the scope. When the correct adjustment is obtained the sharp spikes on the waveform should be centered on the zero-crossing points of the sine-wave. See Figure 6-2, which shows the waveform at that point. Since the capacitance of the tool will slightly affect the waveform, be sure that you look at it with the tool removed to check the final adjustment. Disconnect the oscilloscope.

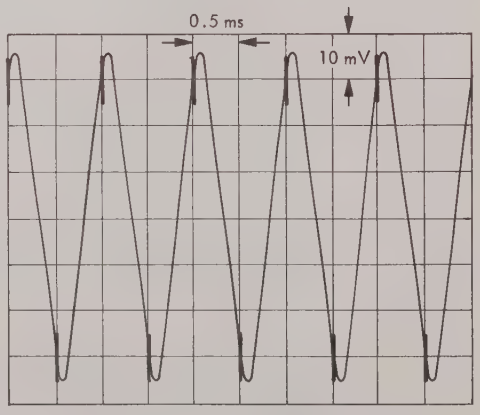
e. Connect the attenuator input to the power supply. The positive terminal of the supply should be connected to the common side of the attenuator and tied to bench ground. Leave the switch on the attenuator set to 'off'. Set the power supply to 0 V. Connect the voltmeter input to TP213 and the low side of the voltmeter to TP209. The voltmeter should be floating free of ground. Adjust A2R181 to obtain 0 V within 10 µV.

f. Move the voltmeter input to TP207 and adjust A2R79 to obtain 0 V within 10 µV.

g. Move the voltmeter input to TP208 and reduce the sensitivity to 1 V full scale. Set the power supply to 0.140 V and turn the switch on the attenuator to 'on'. Adjust A2R85 for -.45 to -.49 V at TP208. Remove the voltmeter and return the attenuator switch to 'off'. Remove the attenuator from the supply and set it on an insulated place.

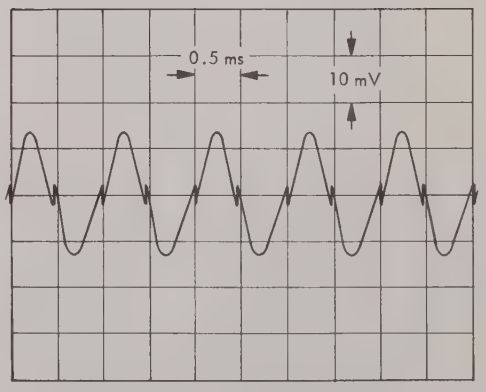
h. Connect the negative side of the power supply to TP207 and the positive side (which should also be connected to earth ground) to TP209. Set the supply to 20 mV. Press the INPUT dB button, set the OFFSET to -20.0 dB. Use the REFERENCE control to center the trace. When the final centering adjustment is made, the REF LINE switch should be in the center and the 0.1 dB/DIV switch depressed. Set the supply to -2.0 mV and the OFFSET to -30 and adjust the NOISE LEVEL control to center the trace. Repeat the 20 mV setting described above and the 2.0 mV adjustment as required. Set the power supply to 2.0 V and the OFFSET to 00.0 dB. Center the trace with A2R6. Check to see that the trace is centered with -0.2V and -10.0 dB OFFSET and with -20 V and +10.0 dB OFFSET. It should track within ± .02 dB except at +10.0 dB it can be ± .04 dB. Disconnect the power supply.

i. Reconnect the attenuator and detector cable to the power supply (common positive tied to bench ground). Turn the switch on the attenuator 'on' and set the power supply to 0.070 V.



TP211 WITH A2C88 INCORRECTLY ADJUSTED

FIGURE 6-2a



TP211 WITH A2C88 CORRECTLY ADJUSTED

FIGURE 6-2b

WAVEFORMS AT TP211

FIGURE 6-2

Set the OFFSET switches to -30. Press the dB button and center the trace using the REFERENCE control. Make the final adjustment on 0.1 dB/DIV. Be sure that the REF LINE switch is centered. Set the power supply to -7 mV and the OFFSET switches to -40.0 dB. Center the trace with the NOISE LEVEL control. Remove the attenuator and connect the detector cable directly to the power supply, observing the same polarity as with the attenuator. Set the OFFSET to -00.0 dB and the power supply to 0.228 V.

In making the following adjustments it will be easiest to start using 1 dB/DIV then, as the adjustment improves, increasing the sensitivity to 0.1 dB/DIV. The final adjustment must be made at 0.1 dB/DIV.

Adjust A2R89 to center the trace. Increase the voltage to 0.844 V and set the OFFSET +10.0 dB. Note where the trace is with respect to the center line. Adjust A2R94 so that the trace moves to a point five times as far on the opposite side of the center line as it had been. For example, if the trace is found to be 0.1 dB above the center line, it should be adjusted to be 0.5 dB below the line. Now return to 0.228 V and recenter the line using A2R89. Repeat this procedure until the line is centered for both 0.229 V and 0.844 V at 0.1 dB/DIV with the respective OFFSET settings. When finished, leave the voltage at 0.228 V.

j. Adjust the front panel HIGH LEVEL control to the center of its range. Press the INPUT dBm button, set the OFFSET to 00.0 and adjust A2R21 to center the trace. The final adjustment should be made using the 0.1 dB/DIV sensitivity.

k. When finished with step j, the trace should be centered on the 0.1 dB/DIV range. Press the 10 dB/DIV button and adjust A2R28 to recenter the trace. The adjustment has relatively limited range and when it is adjusted correctly the trace should go right across the center graticule mark.

l. Perform this step for units with memory. Connect the function generator to the input to the horizontal plug-in. Set the generator and the controls on the horizontal plug-in to give a linear (ramp) sweep that just covers the screen at 40 ms per sweep. That is, 4 ms per screen division. Since the retrace time is substantial for most function generators, this will be a sweep repetition frequency somewhat less than 16 per second. Press the 10 dB/DIV and ACCESS MEMORY buttons. Adjust the REFERENCE control to put the trace on the screen. Momentarily press the PRESS TO STORE button. Press INPUT MINUS MEMORY and 1 dB/DIV buttons. If the trace is not centered, slightly reset A3R8 and repeat this step. It is normal to see small deviations due to the resolution of the memory.

m. Connect the detector cable to the attenuator and the attenuator to the power supply (positive ground). Set the power supply to 0 V and the attenuator switch to 'off'. Adjust the front panel NOISE LEVEL control (see Section 3.3.2 b--the attenuator replaces the detector). Turn the attenuator switch to 'on' and set the power supply to 7 mV. Press the 5 dB/DIV button and bring the trace on screen with the OFFSET switch. Adjust A2R163 for minimum 1 kHz noise.

n. Set the power supply to 22.9 V and press the 10 dB/DIV button. Turn the switch off and observe the action. The trace should move rapidly for 40 dB then settle slowly downward. It may be necessary to reposition the trace to see the entire movement. Adjust A2R186 so that when the switch is turned off you see the best response speed without excessive overshoot.

If you have the detector with which the plug-in will be used you can improve the tracking with that detector. The following procedure will adjust the instrument for optimum tracking with a specific detector. NOTE: The adjustments called for can be made thru holes in the right hand cover of the plug-in.

o. Connect the detector to the DETECTOR INPUT. Screw the detector to the precision attenuator of Section 6.3.1 j. Connect the input of the attenuator to the CALIBRATOR OUTPUT of the horizontal plug-in. Set the attenuator for 40 dB. With the calibrator turned off, adjust the NOISE LEVEL control per Section 3.3.2 b.

Turn the calibrator on, press dBm, set the OFFSET switch to -30 and adjust the HIGH LEVEL control so that the trace is as much above or below the reference line as is called for by the calibration data for the attenuator. The final adjustment should be done on the 0.1 dB/DIV setting. Set the attenuator to 10 dB and the OFFSET to 00.0. If necessary, slightly readjust A2R89 to bring the trace as much above or below the reference line as called for by the attenuator calibration data. Repeat at 0 attenuation and +10.0 OFFSET, adjusting A4R1 (or A2R72 on units with code 17 or higher) if necessary. Remove the attenuator. This step completes the calibration procedure.

6.4 TROUBLE SHOOTING

In order to localize the source of trouble in an instrument such as this, it is necessary to have a rather detailed working knowledge of the instrument. You are urged to read Section 5, Circuit Description and to make use of the circuit diagrams of Section 7. Relevant dc voltages are shown on the schematic diagrams and are typical of values to be found during normal operation. The data were taken with a digital voltmeter with 10 M ohm input impedance. The detector was connected to the calibrator of a horizontal plug-in and the calibrator turned on. The display switches of the horizontal plug-in were set so the channel under test was on and the other channel off. The controls of the vertical plug-in under test were set as follows:

OFFSET	00.0
SMOOTH	OFF
DISPLAY	dBm
DISPLAY	10 dB/DIV
REF LINE	CENTER LINE

In general, dc voltages will not be shown at points where they will vary substantially depending upon the mode of operation. In many cases, such points will have a waveform shown. Figures 6-3, 6-4 and 6-5 show various waveforms. Figures 6-6 and 6-7 are timing diagrams for the memory section.

Since the vertical plug-ins are only part of the total system, trouble in other parts of the system can lead the technician to suspect the vertical units when, in fact, the trouble is elsewhere. Be sure that the power supplies are at their correct voltage and that the deflection circuits of the mainframe are working. Also, the memory depends upon signals from the horizontal unit; be sure that these are normal.

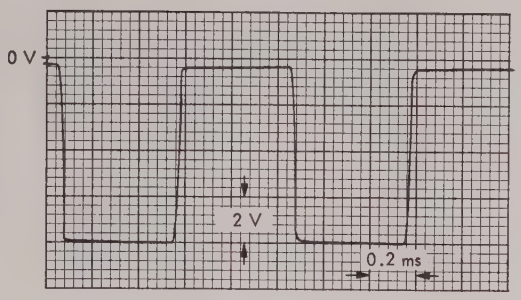
6.5 SEMICONDUCTOR DEVICES

A variety of semiconductor devices are used in this instrument. The type numbers shown are either EIA registered numbers or manufacturer's numbers. Devices meeting the corresponding specifications can be used for replacement purposes and can probably be obtained locally. Individual instruments may have equivalent devices of other manufacturers installed and the type number may not agree with those shown on the schematic diagram or parts list.

6.6 ACCESS TO INTERNAL COMPONENTS

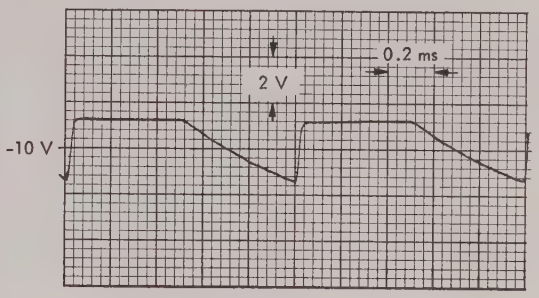
Access to the internal components is obtained by removing the side covers. The covers are retained in slots and held in place by two screws at the rear of the unit.

Access to the back side of the PC boards in units with memory is obtained by removing the screws that secure the memory board and swinging the board out on its flat flexible cable. Remove the shield between the boards if access to the rear of the amplifier board is required.



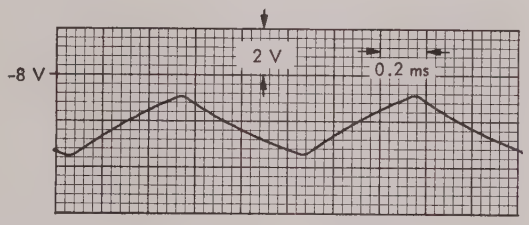
Q33 COLLECTOR
Q32 IS SIMILAR BUT OUT OF PHASE

FIGURE 6-3a



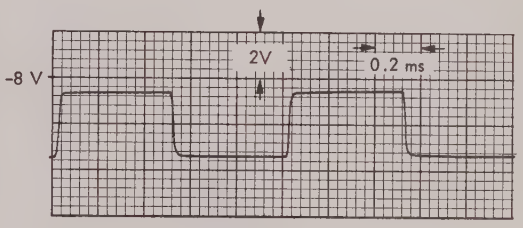
Q32 AND Q33 COMMON EMITTER

FIGURE 6-3b



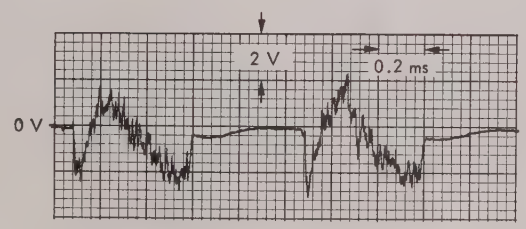
Q32 BASE

FIGURE 6-3c



Q33 BASE

FIGURE 6-4d



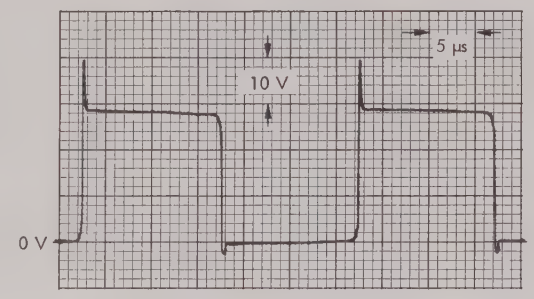
Q22 DRAIN

FIGURE 6-4e

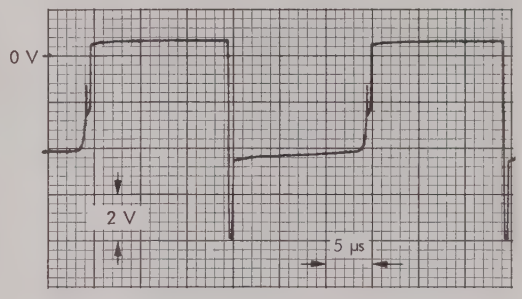
NOTE: A HIGH IMPEDANCE SCOPE PROBE WAS USED. FOR WAVEFORMS AT U14, SEE FIGURE 6-2, THE TRIGGER SOURCE WAS TP210.

WAVEFORMS OF THE CHOPPING CIRCUIT

FIGURE 6-3



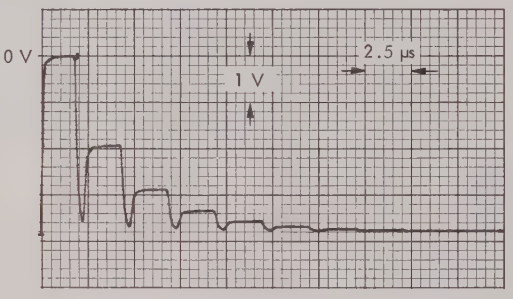
Q14 OR Q15 COLLECTOR
FIGURE 6-4a



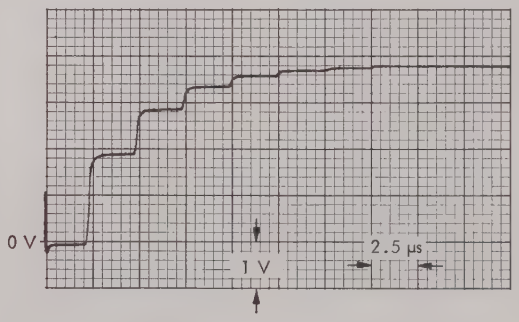
Q14 OR Q15 BASE
FIGURE 6-4b

NOTE: INTERNAL TRIGGERING WAS USED.

WAVEFORMS OF THE ISOLATED POWER SUPPLY
FIGURE 6-4



TP36 WITH THE TRACE SET JUST OFF SCREEN AT THE TOP OF THE CRT PRIOR TO PRESSING "STORE" BUTTON.
FIGURE 6-5a

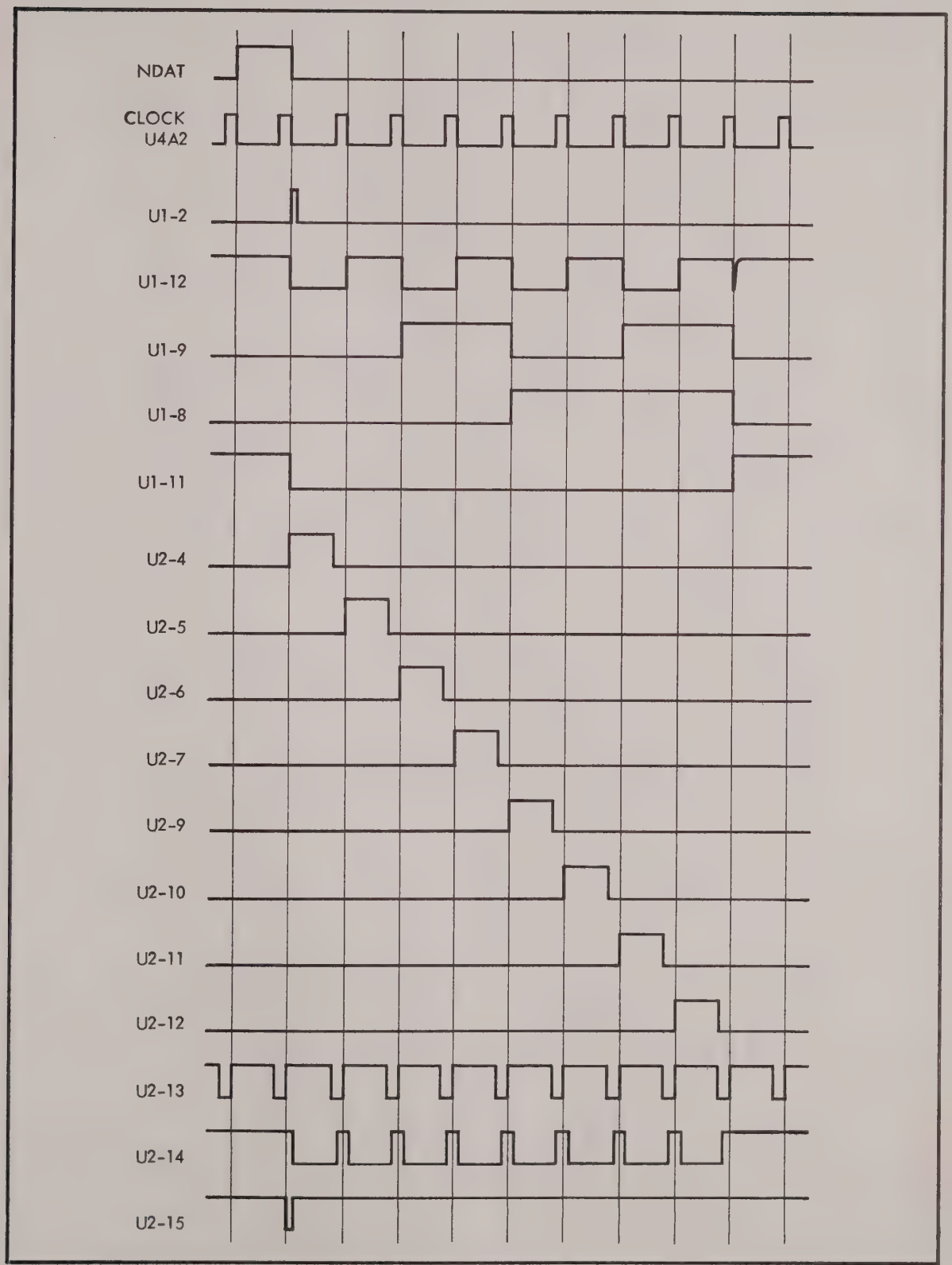


TP36 WITH THE TRACE SET JUST OFF SCREEN AT THE BOTTOM OF THE CRT PRIOR TO PRESSING "STORE" BUTTON.
FIGURE 6-5b

NOTE: THE TRIGGER SOURCE WAS TP210.

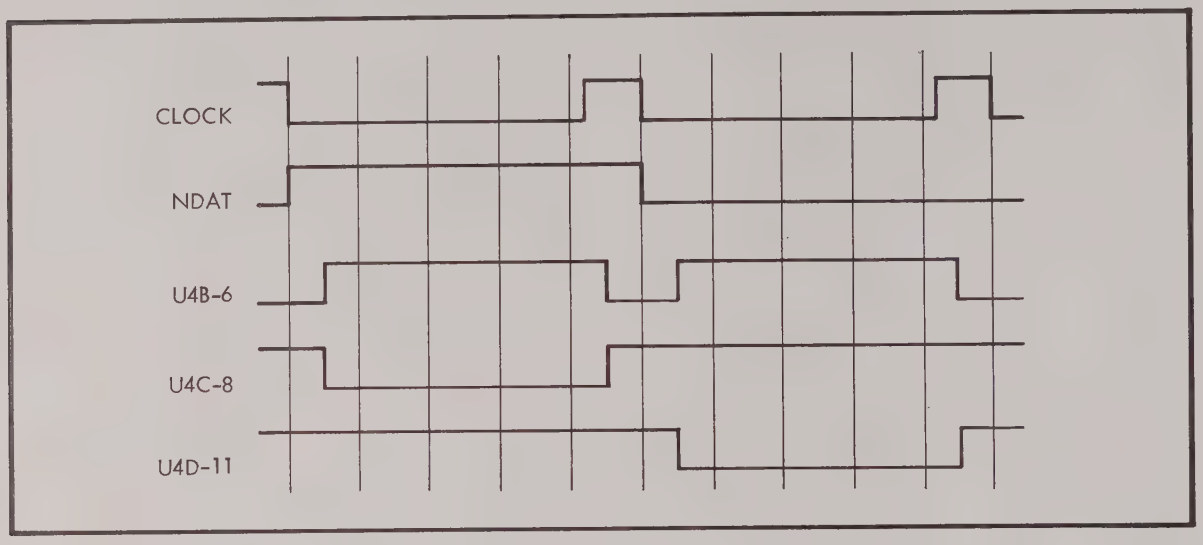
WAVEFORMS OF THE DIGITAL TO ANALOG CONVERTER AT TP36
FIGURE 6-5

Figure 6-6: Timing diagram for the memory unit. The logic signals shown are for a 50 ms sweep applied to the Horizontal Input. ACCESS MEMORY and STORE are both depressed. The trace was positioned just off screen at the top of the CRT prior to pressing STORE. Each division of the diagram is approximately 2.5 µs. A logic "1" is greater than 2.4 V and a "0" is less than 0.4 V.



TIMING DIAGRAM
FIGURE 6-6

Figure 6-7: Expanded scale timing diagram showing the relationships between the clock and signals which are delayed slightly. The horizontal scale is 0.5 μs/Div.



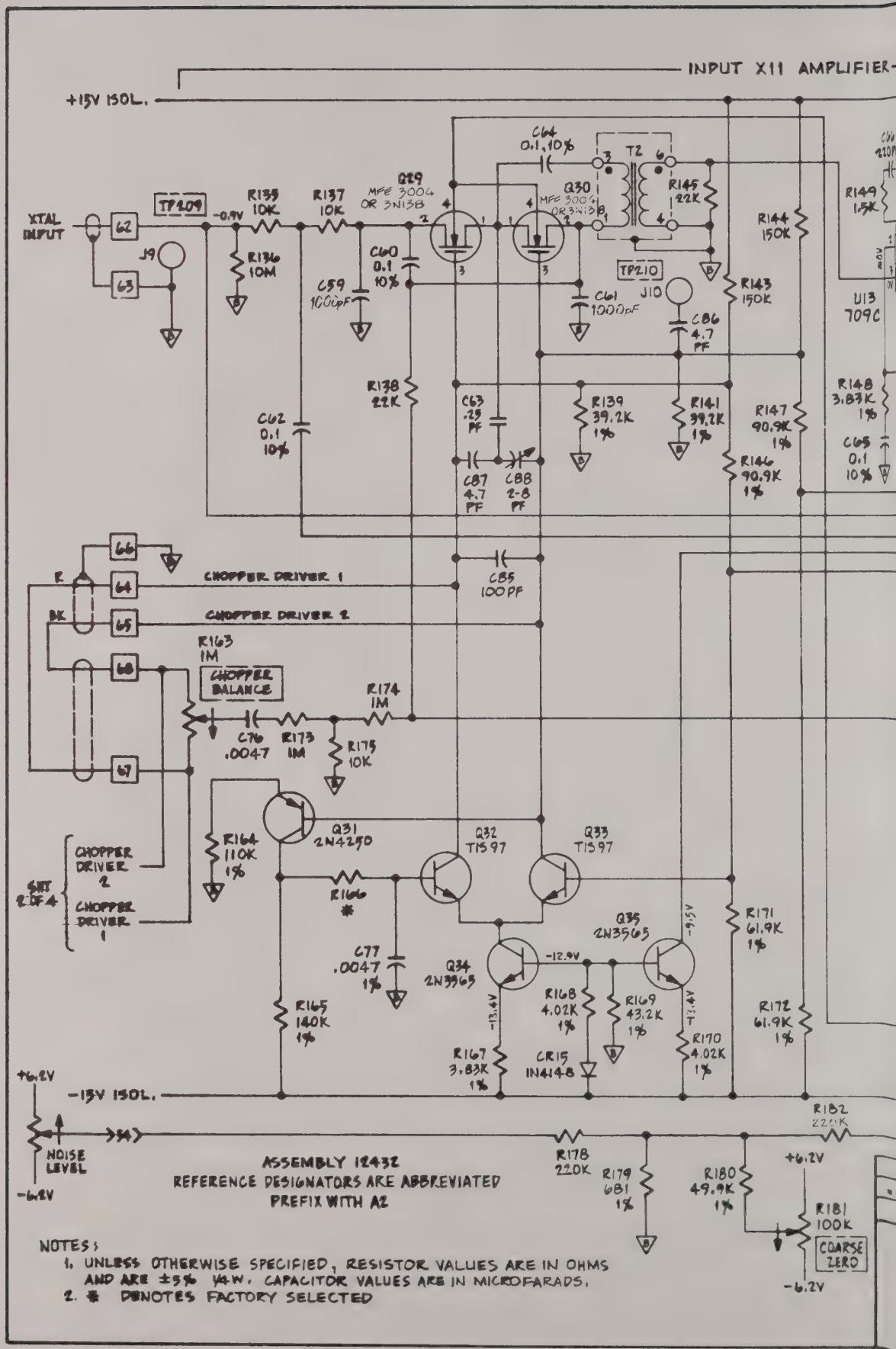
TIMING DIAGRAM
FIGURE 6-7

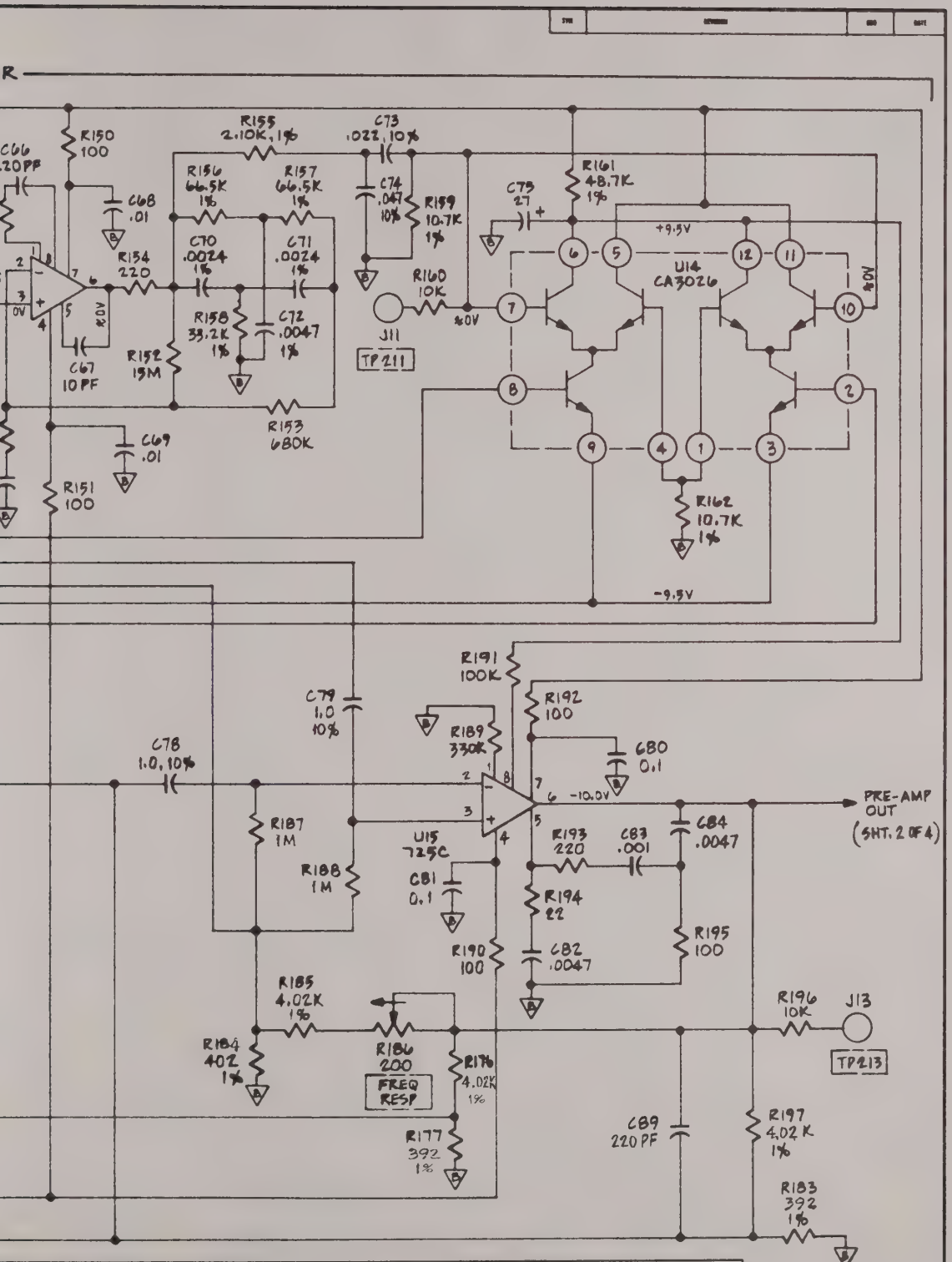
SECTION 7

SCHEMATIC DIAGRAMS

Schematic diagrams in this section are filed in the order of their drawing numbers.

Used With Model No.	Reference Designator	Title	Drawing Number
1038-V10	---	LOG AMPLIFIER	12725
1038-V10	A1	DIGIT SWITCH	12725
1038-V10	A2	LOG AMPLIFIER (4 Sheets)	12433
1038-V11	---	LOG AMPLIFIER	12725
1038-V11	A1	DIGIT SWITCH	12725
1038-V11	A2	LOG AMPLIFIER (4 Sheets)	12433
1038-V11	A3	MEMORY CIRCUIT (5 Sheets) Sheets 1, 2, & 3 applies to -V11	12864
1038-V12	---	LOG AMPLIFIER	12725
1038-V12	A1	DIGIT SWITCH	12725
1038-V12	A2	LOG AMPLIFIER (4 Sheets)	12433
1038-V12	A3	MEMORY CIRCUIT (5 Sheets) Sheets 1, 4, & 5 applies to -V12	12864

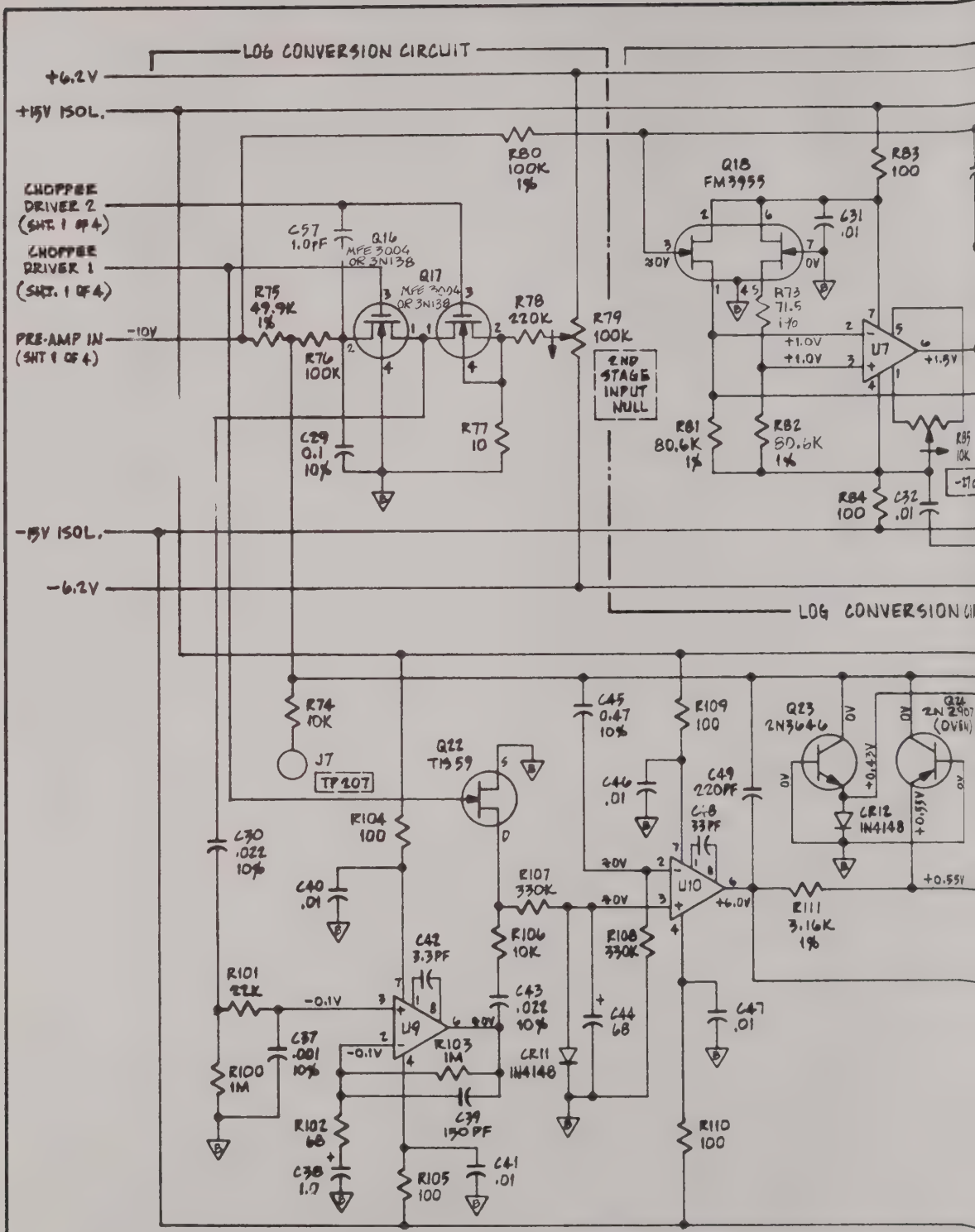

INPUT X11 AMPLIFIER
+15V ISOL.
XTAL INPUT
62
63
J9
TP209
-0.9V
R135 10K
R136 10M
R137 10K
C59 1000pF
Q29 MFE 3004 OR 3N138
Q30 MFE 3004 OR 3N138
C60 0.1 10%
C64 0.1, 10%
T2
R145 22K
R144 150K
TP210
J10
C61 1000pF
C86 4.7 PF
R143 150K
R138 22K
C62 0.1 10%
C63 .29 PF
C87 4.7 PF
C88 2-8 PF
R139 39.2K 1%
R141 39.2K 1%
R147 90.9K 1%
R146 90.9K 1%
R149 1.5K
U13 709C
R148 3.83K 1%
C65 0.1 10%
66
64
65
68
67
R
BK
CHOPPER DRIVER 1
CHOPPER DRIVER 2
C85 100PF
R163 1M
CHOPPER BALANCE
R174 1M
C76 .0047
R173 1M
R175 10K
SET 2 OF 4
CHOPPER DRIVER 2
CHOPPER DRIVER 1
R164 110K 1%
Q31 2N4250
Q32 TIS97
Q33 TIS97
R166 *
C77 .0047 1%
Q34 2N3963
Q35 2N3963
-12.0V
-9.5V
-13.4V
R165 140K 1%
R167 3.83K 1%
R168 4.02K 1%
CR15 IN4148
R169 43.2K 1%
R170 4.02K 1%
R171 61.9K 1%
R172 61.9K 1%
+6.2V
-13V ISOL.
NOISE LEVEL
-6.2V
R182 220K
R178 220K
R179 681 1%
R180 49.9K 1%
R181 100K
COARSE ZERO
ASSEMBLY 12432
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A2
NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. * DENOTES FACTORY SELECTED



LIST OF MATERIAL

NEXT ASSY

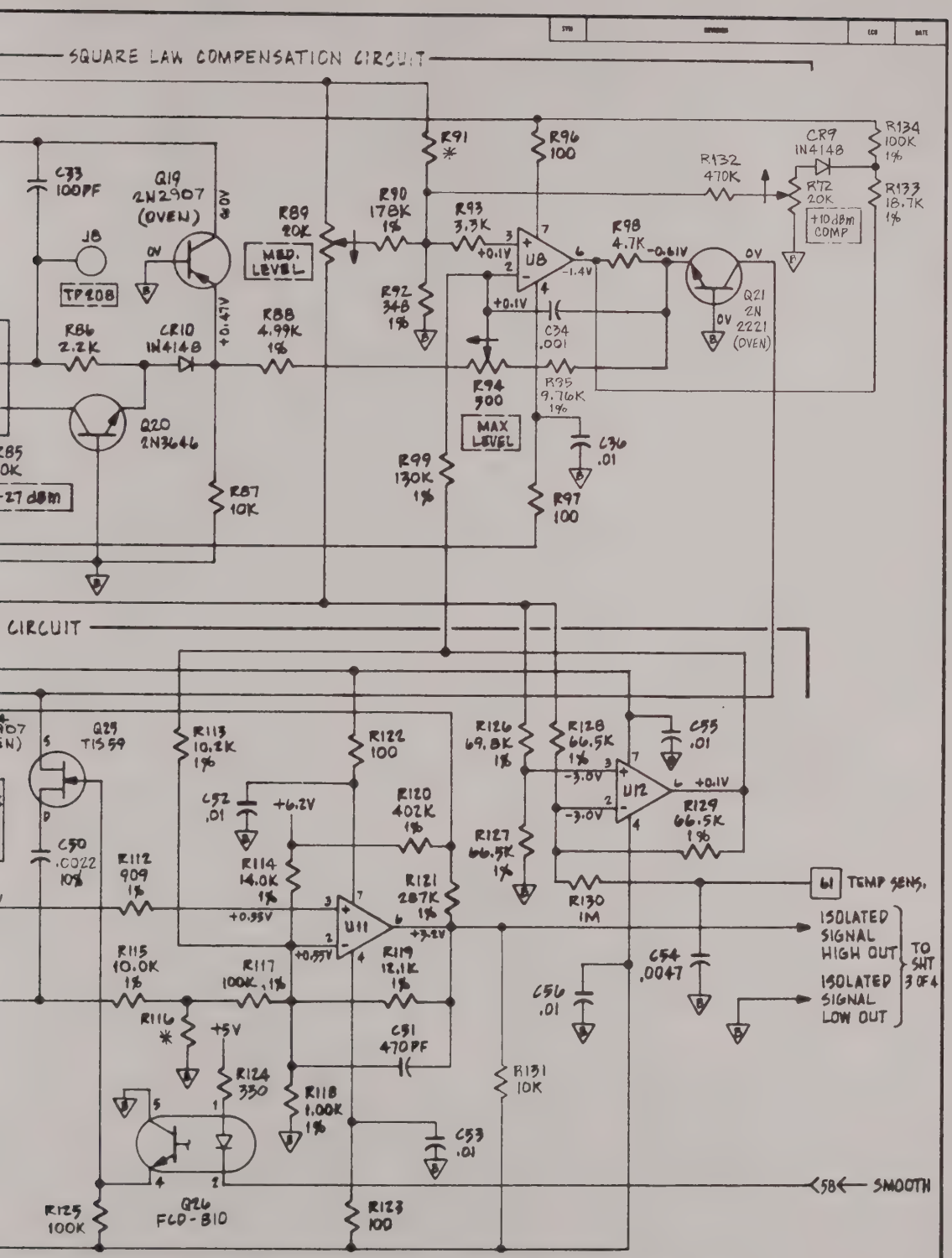
	Chesley Stone	9-10-73	PACIFIC MEASUREMENTS INCORPORATED
	RHB	2-6-74	LOG AMPLIFIER
			12433 G
			SHEET 1 OF 4



NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% ¼W. CAPACITOR VALUES ARE IN MICROFARADS.
2. * DENOTES FACTORY SELECTED

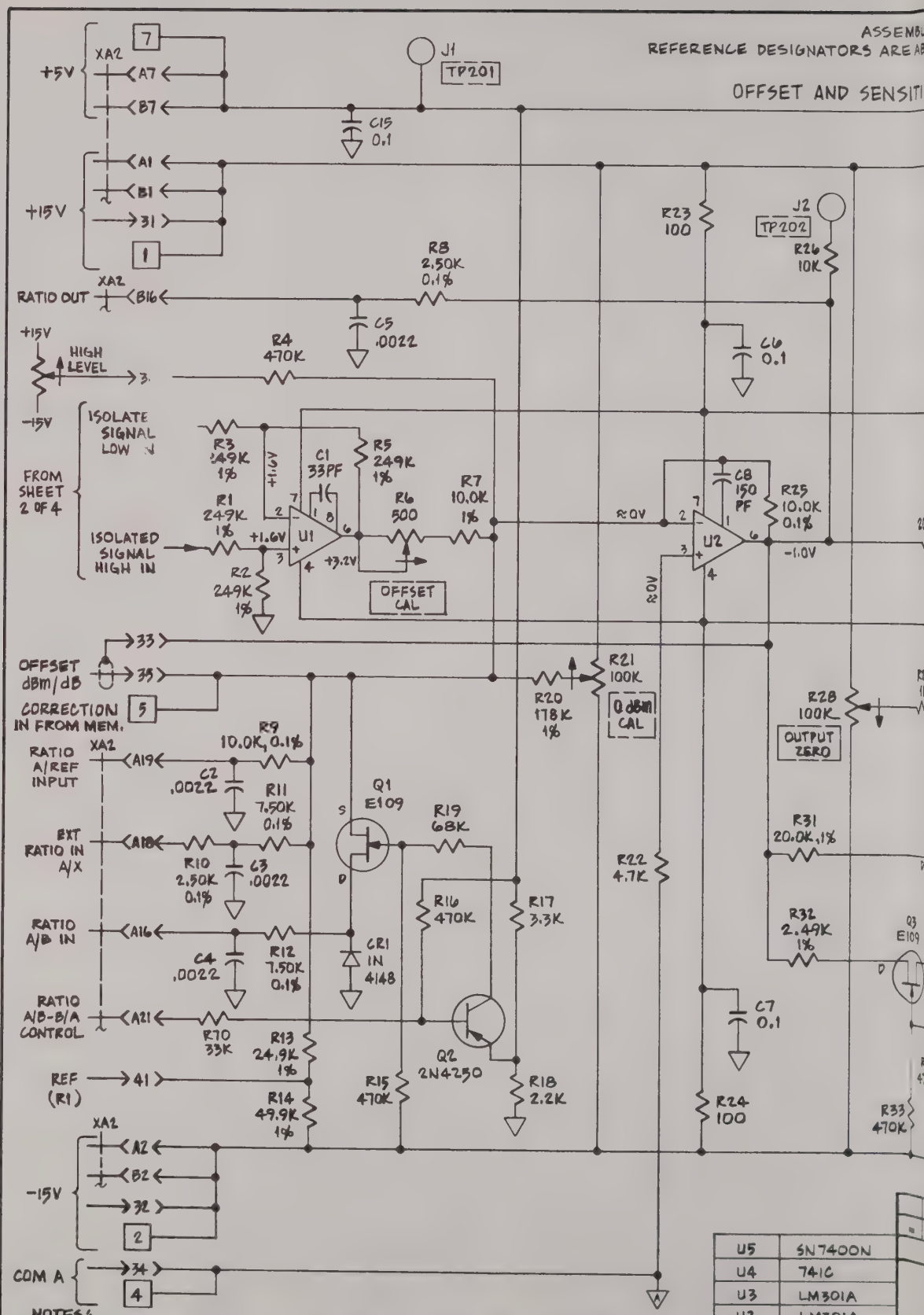
REF DESIG.	TYPE
U9, U10	LM301A
U7, U8 U11, U12	741C



LIST OF MATERIAL

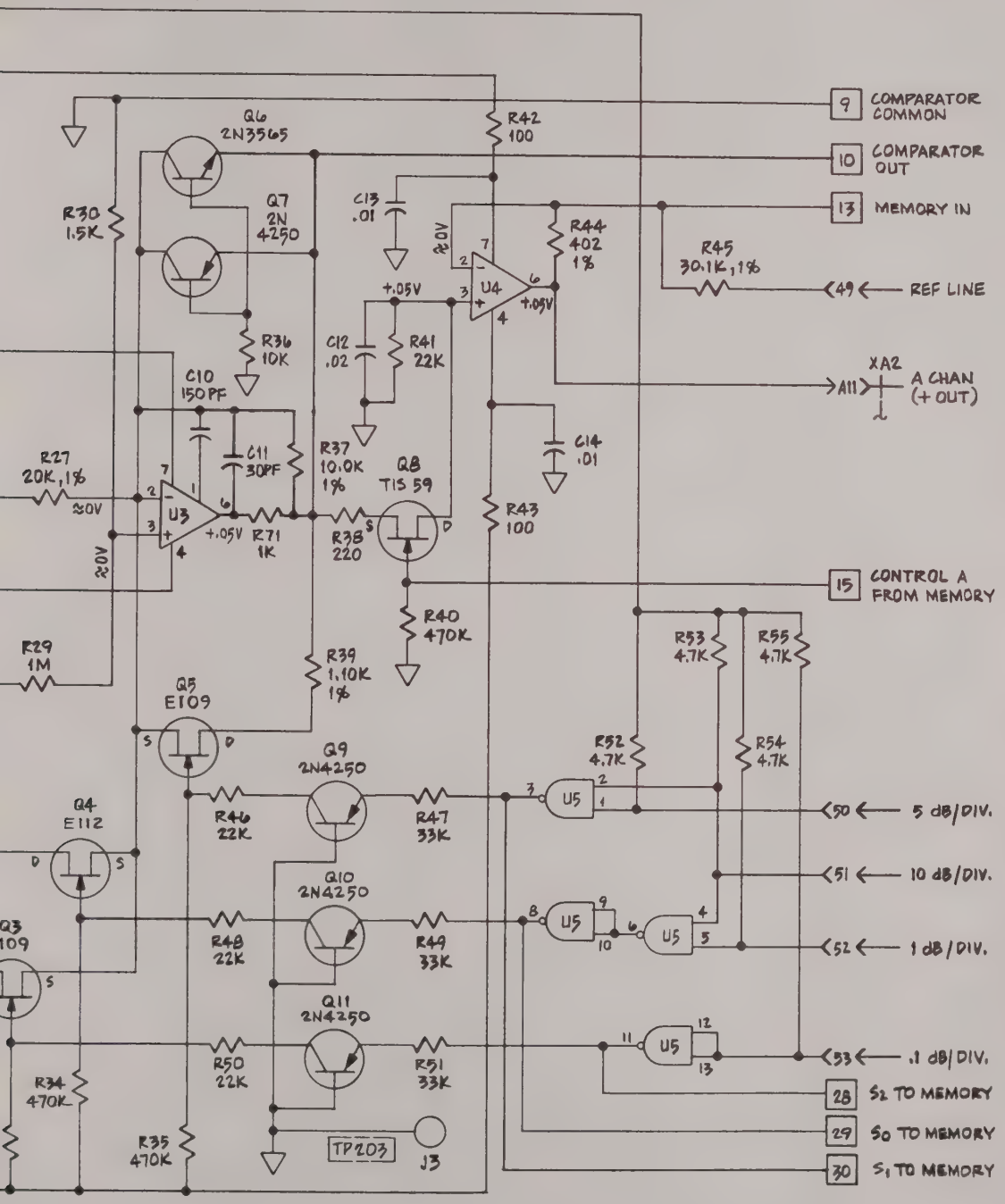
NEXT ASSY

Charles Y Yeo	9-10-73	PACIFIC MEASUREMENTS INCORPORATED
RHB	2-6-74	LOG AMPLIFIER
		12433 J
		SHEET 2 OF 4


ASSEMBL
REFERENCE DESIGNATORS ARE AB
OFFSET AND SENSITI
+5V
XA2
7
A7
B7
J1
TP201
C15
0.1
+15V
A1
B1
31
1
R23
100
J2
TP202
R26
10K
R8
2.50K
0.1%
RATIO OUT
B16
C5
.0022
C6
0.1
R4
470K
HIGH LEVEL
3
-15V
ISOLATE SIGNAL LOW
FROM SHEET 2 OF 4
R3
249K
1%
C1
33PF
R5
249K
1%
R7
10.0K
1%
R1
249K
1%
ISOLATED SIGNAL HIGH IN
+1.6V
U1
+3.2V
R6
500
R2
249K
1%
OFFSET CAL
≈0V
C8
150 PF
R25
10.0K
0.1%
U2
-1.0V
≈0V
33
OFFSET dBm/dB
35
CORRECTION IN FROM MEM.
5
R21
100K
R20
178K
1%
0 dBm CAL
R28
100K
OUTPUT ZERO
R9
10.0K, 0.1%
RATIO A/REF INPUT
A19
C2
.0022
R11
7.50K
0.1%
Q1
E109
S
D
R19
68K
EXT RATIO IN A/X
A18
R10
2.50K
0.1%
C3
.0022
R31
20.0K, 1%
R22
4.7K
R16
470K
R17
3.3K
R32
2.49K
1%
Q3
E109
RATIO A/B IN
A16
C4
.0022
R12
7.50K
0.1%
CR1
IN
4148
RATIO A/B-B/A CONTROL
A21
R70
33K
R13
24.9K
1%
C7
0.1
Q2
2N4250
REF (R1)
41
R14
49.9K
1%
R15
470K
R18
2.2K
R24
100
R33
470K
XA2
A2
B2
32
2
-15V
COM A
34
4
NOTES:
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.
2. * DENOTES FACTORY SELECTED.
U5 SN7400N
U4 741C
U3 LM301A
U2 LM301A
U1 LM301A
REF DESIG
TYPE

MBLY 12432
E ABBREVIATED PREFIX WITH A2

ITIVITY CIRCUIT



ITEM	QTY	PART NO	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

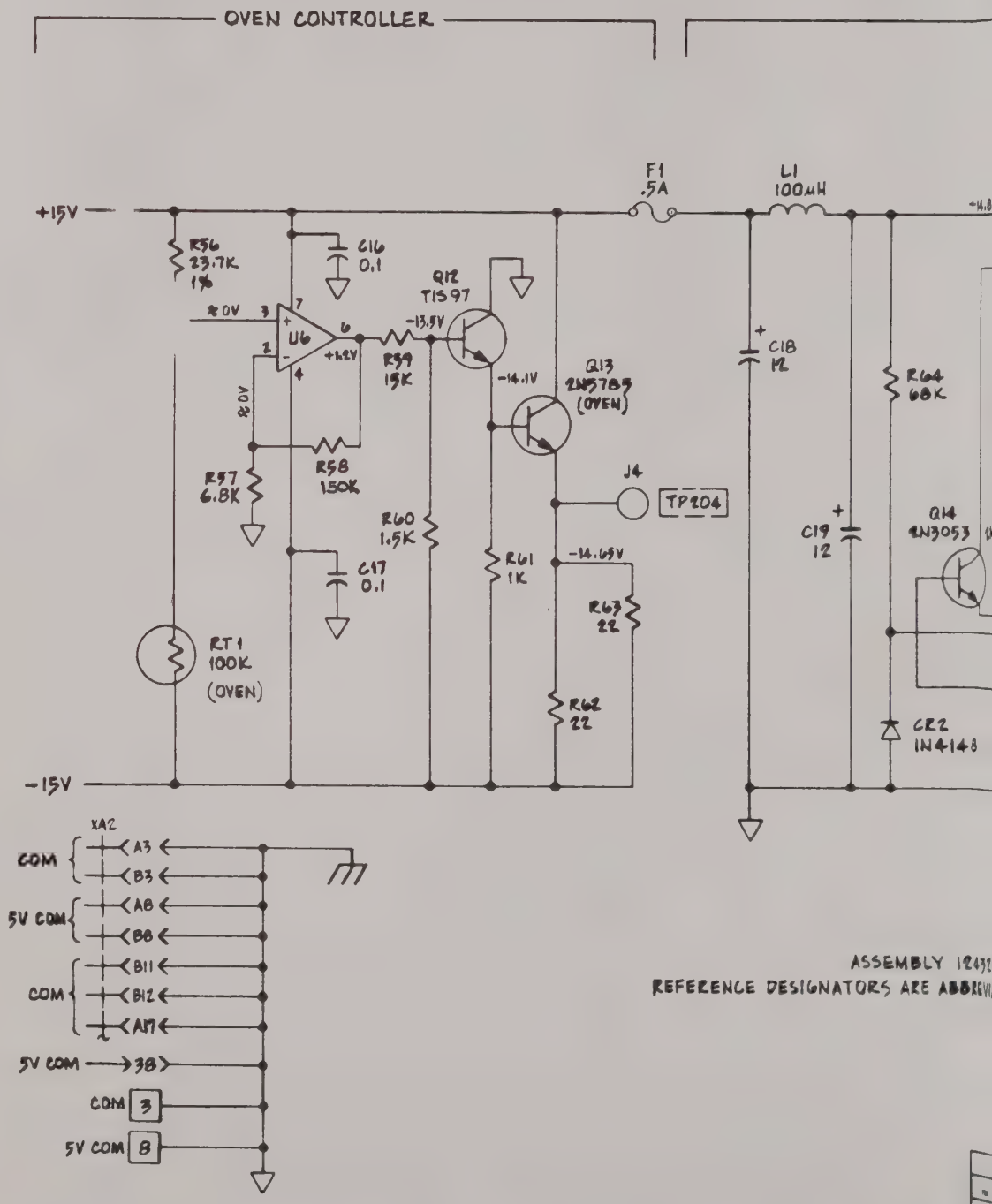
FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE .XX - .015 .XXX - .005 SCALE	DRAWN Curtis Y. Yates	DATE 9-10-73
		ENG RHB	2-6-74
		PROD	

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

LOG AMPLIFIER

DRAWING NO. 12433 REV B

SHEET 3 OF 4



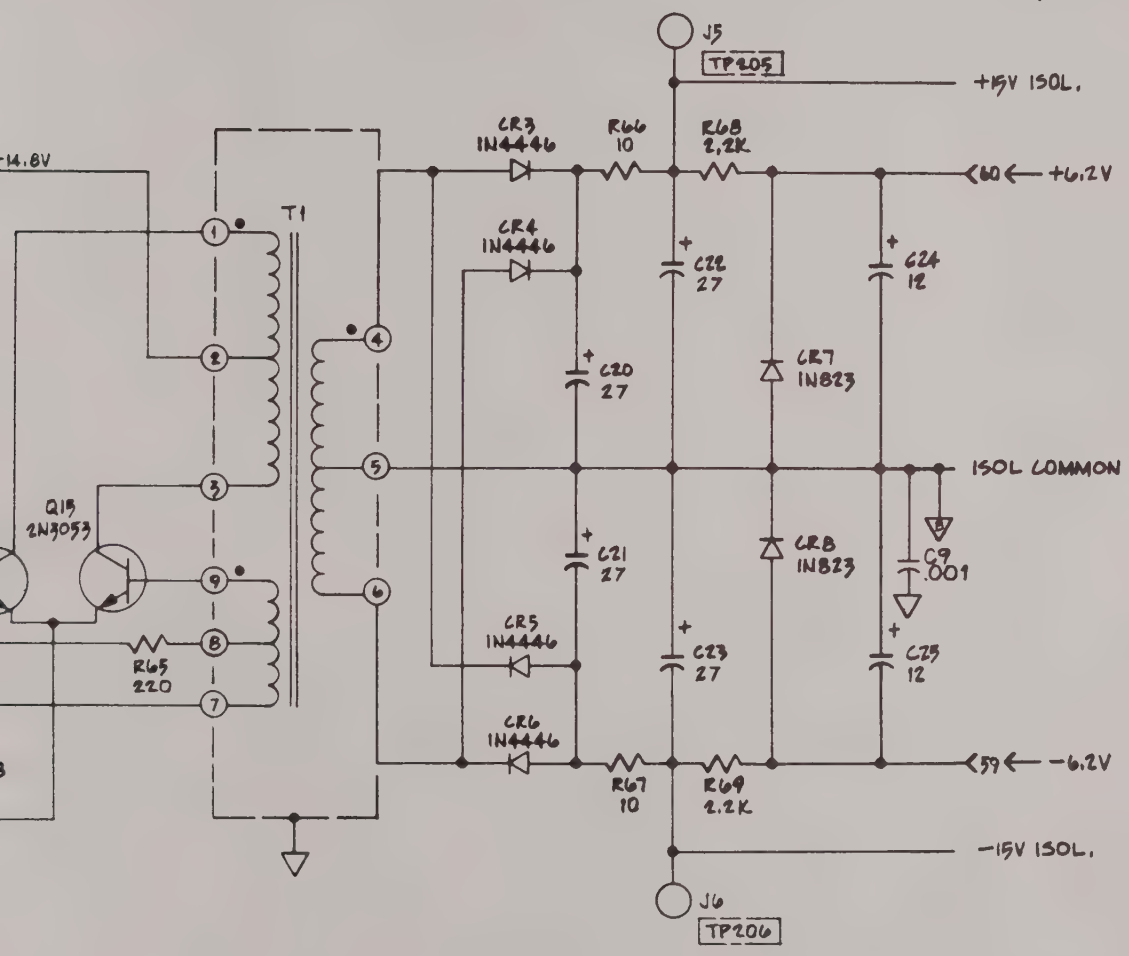
ASSEMBLY 12432
REFERENCE DESIGNATORS ARE ABBREVI

NOTE

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% 1/4W. CAPACITOR VALUES ARE IN MICROFARADS.

U6	741C
REF DESIG	TYPE

ISOLATED POWER SUPPLY

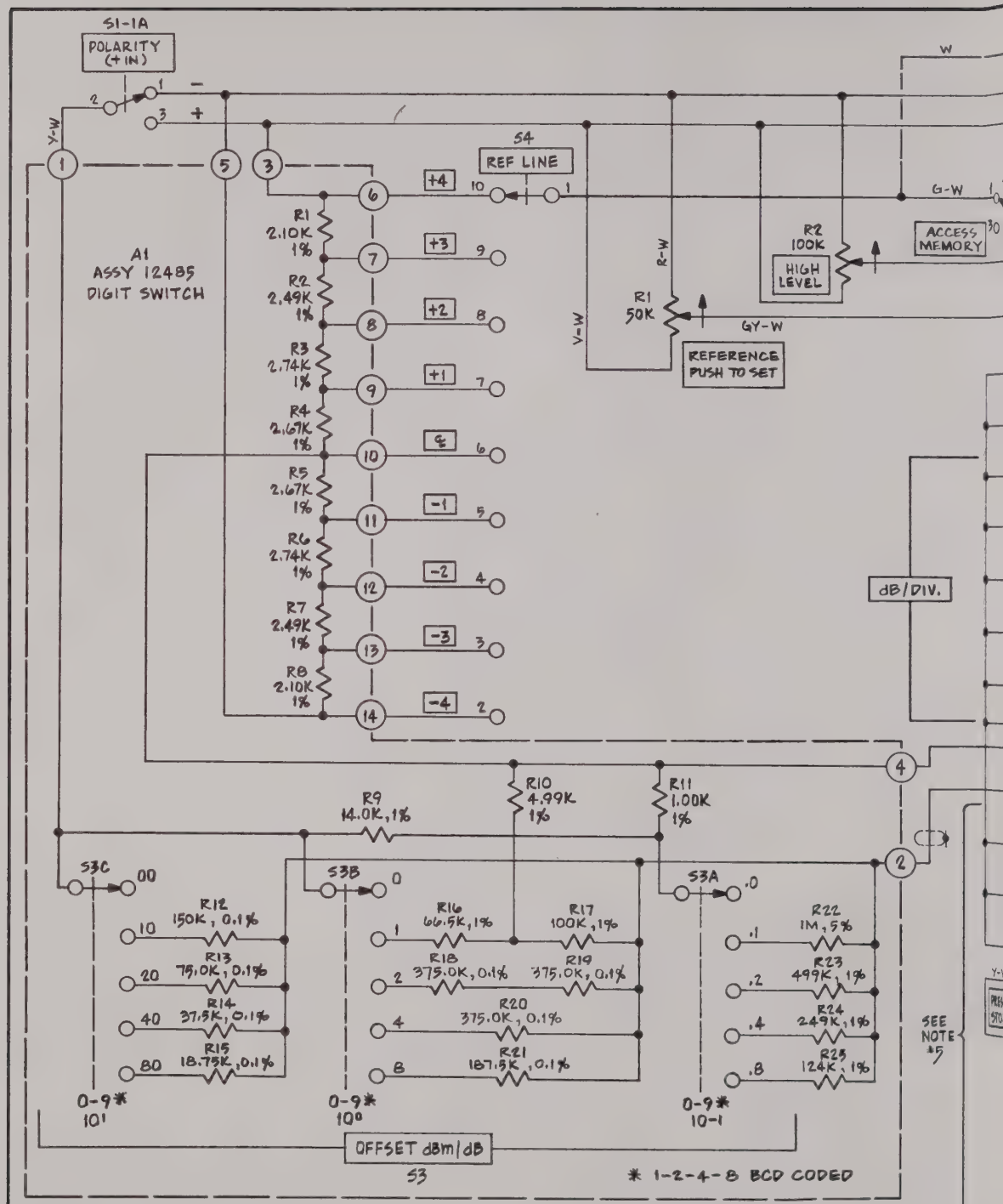


432
REVIATED PREFIX WITH A2

LIST OF MATERIAL

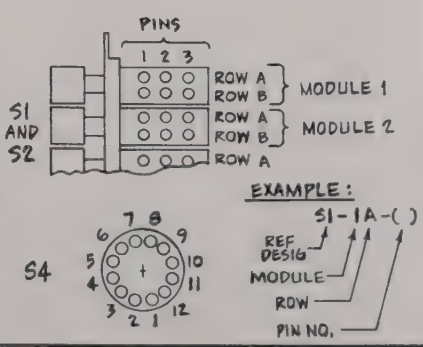
NEXT ASSY

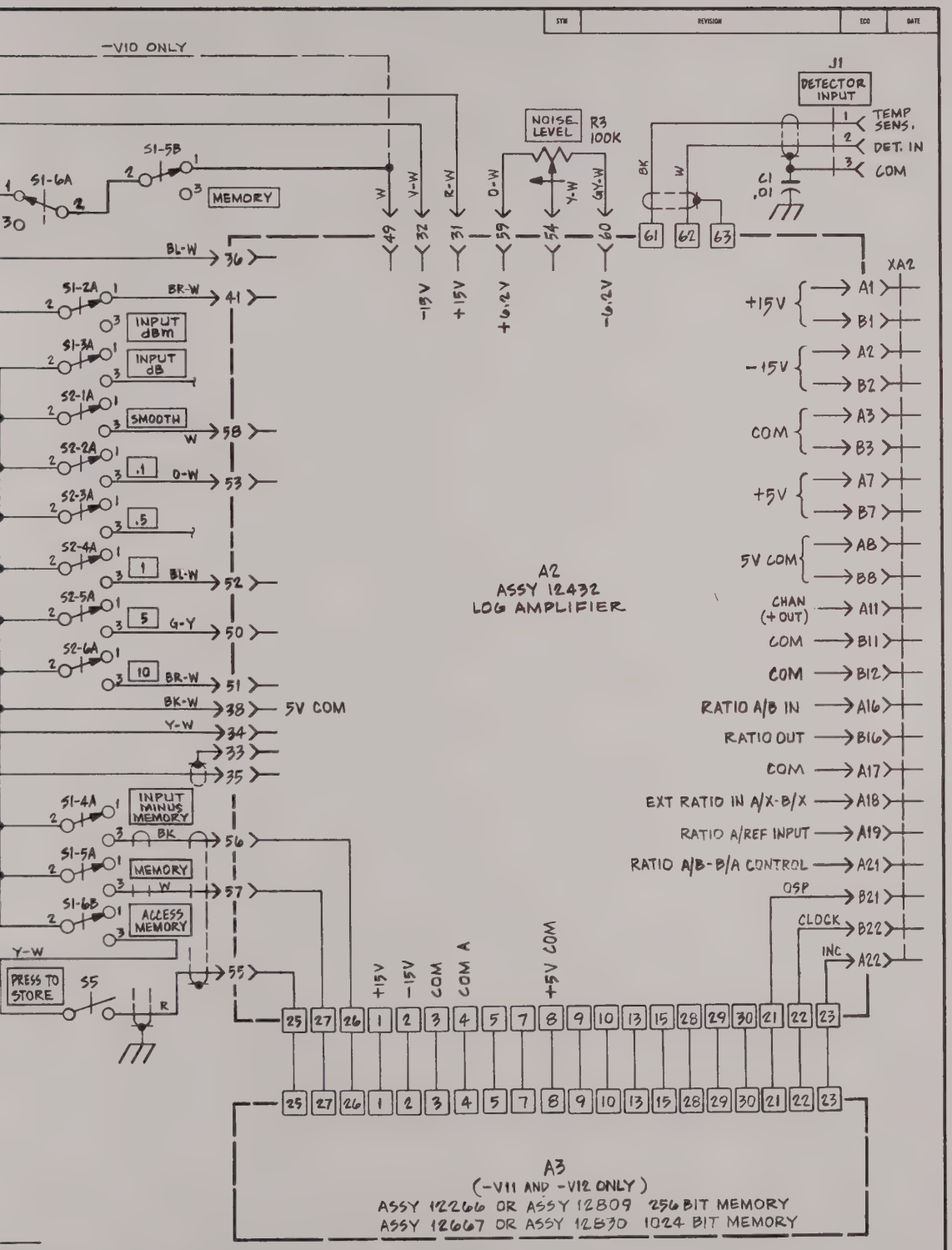
	Victor Stan	9-10-73	PACIFIC MEASUREMENTS INCORPORATED
	RHB	2-6-74	LOG AMPLIFIER
			12433 E
			SHEET 4 OF 4



NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5%, ¼W. CAPACITOR VALUES ARE IN MICROFARADS.
2. TERMINAL NUMBERING FOR SWITCHES S1 AND S2 ARE FOR REFERENCE ONLY. RELATIVE LOCATION OF TERMINALS IS SHOWN IN DIAGRAM AT RIGHT. SWITCHES ARE VIEWED WITH ALL BUTTONS AT OUT POSITION.
3. TERMINAL NUMBERING FOR SWITCH S4 IS FOR REFERENCE ONLY. RELATIVE LOCATION OF TERMINALS IS SHOWN IN DIAGRAM AT RIGHT. SWITCH IS SHOWN VIEWED FROM FRONT WITH KNOB IN EXTREME CW POSITION.
4. POTENTIOMETER ARROW INDICATES CW ROTATION.
5. MODEL 1038-V10 OMIT ASSEMBLY A3, SWITCHES S1-4A, S1-5A, S1-5B, S1-6A, S1-6B AND S5.





SYM	REVISION	ECO	DATE

ITEM	DESG	PART NO	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES

TOLERANCE
XX ± .015
XXX ± .005

SCALE

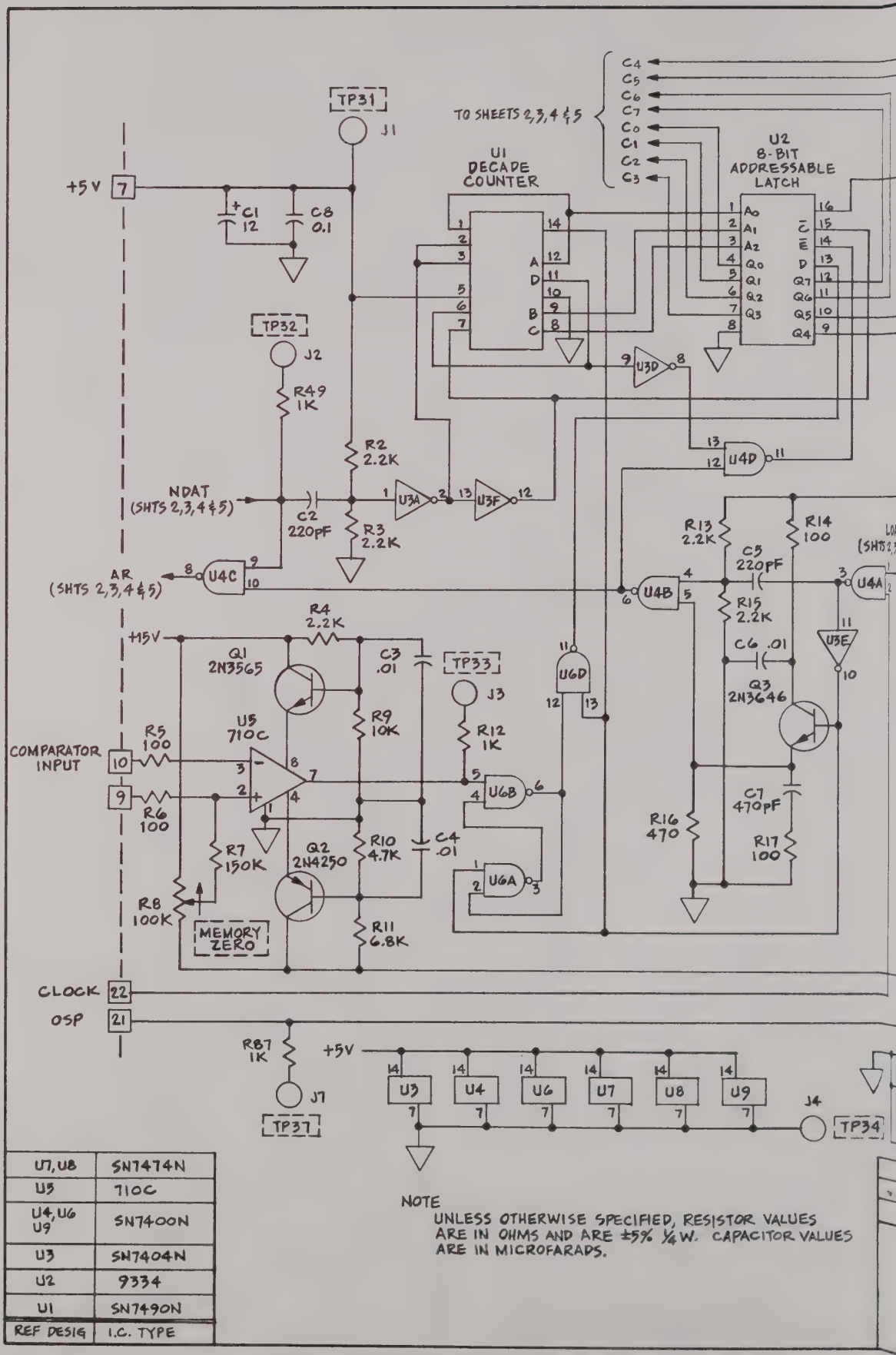
		DATE
DRAWN		9-6-73
ENG	RHE	2-6-74
PROD		

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

LOG AMPLIFIER MODEL 1038-V10,-V11, AND -V12

DRAWING NO 12725 REV B

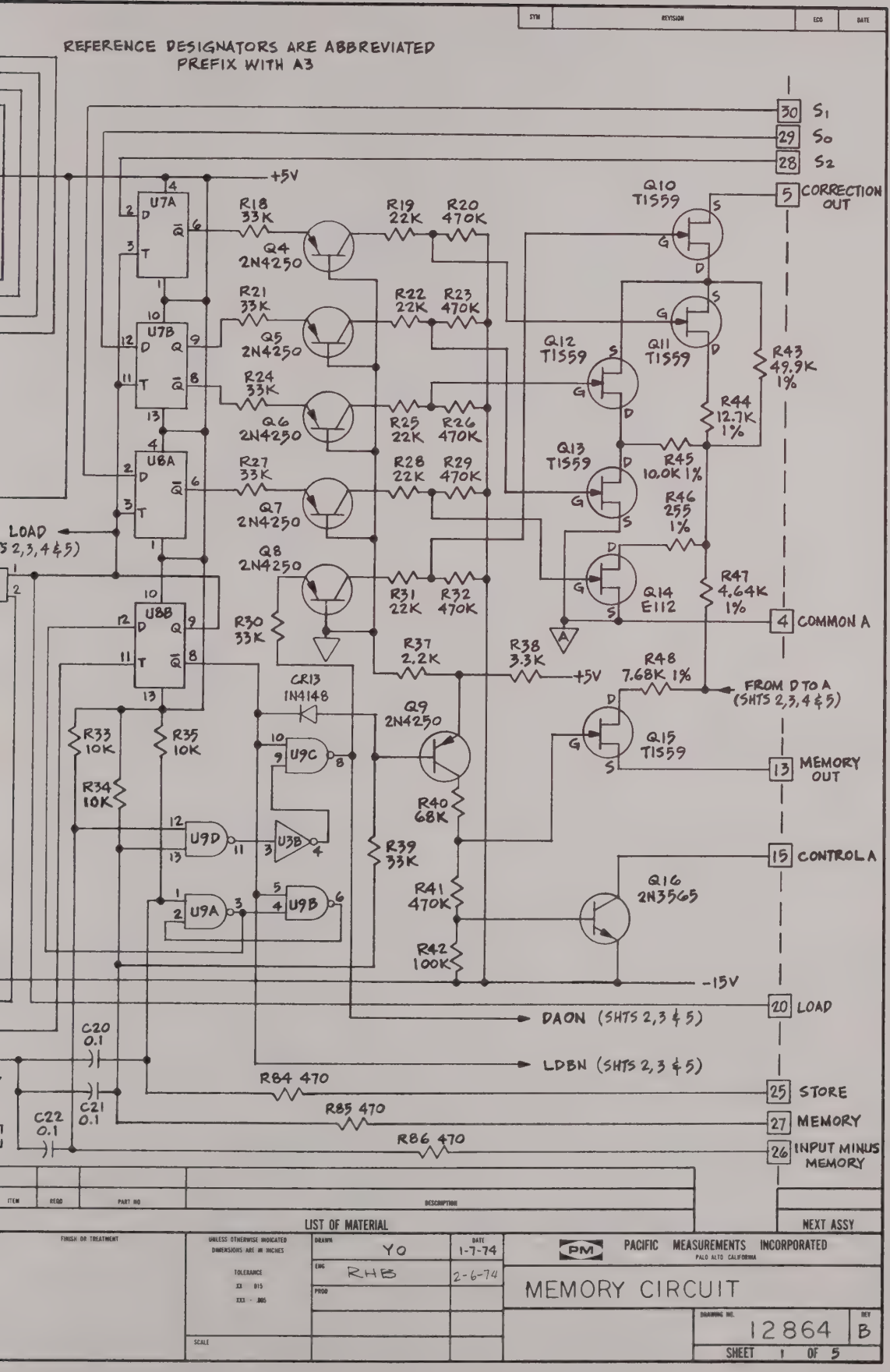
SHEET 1 OF 1

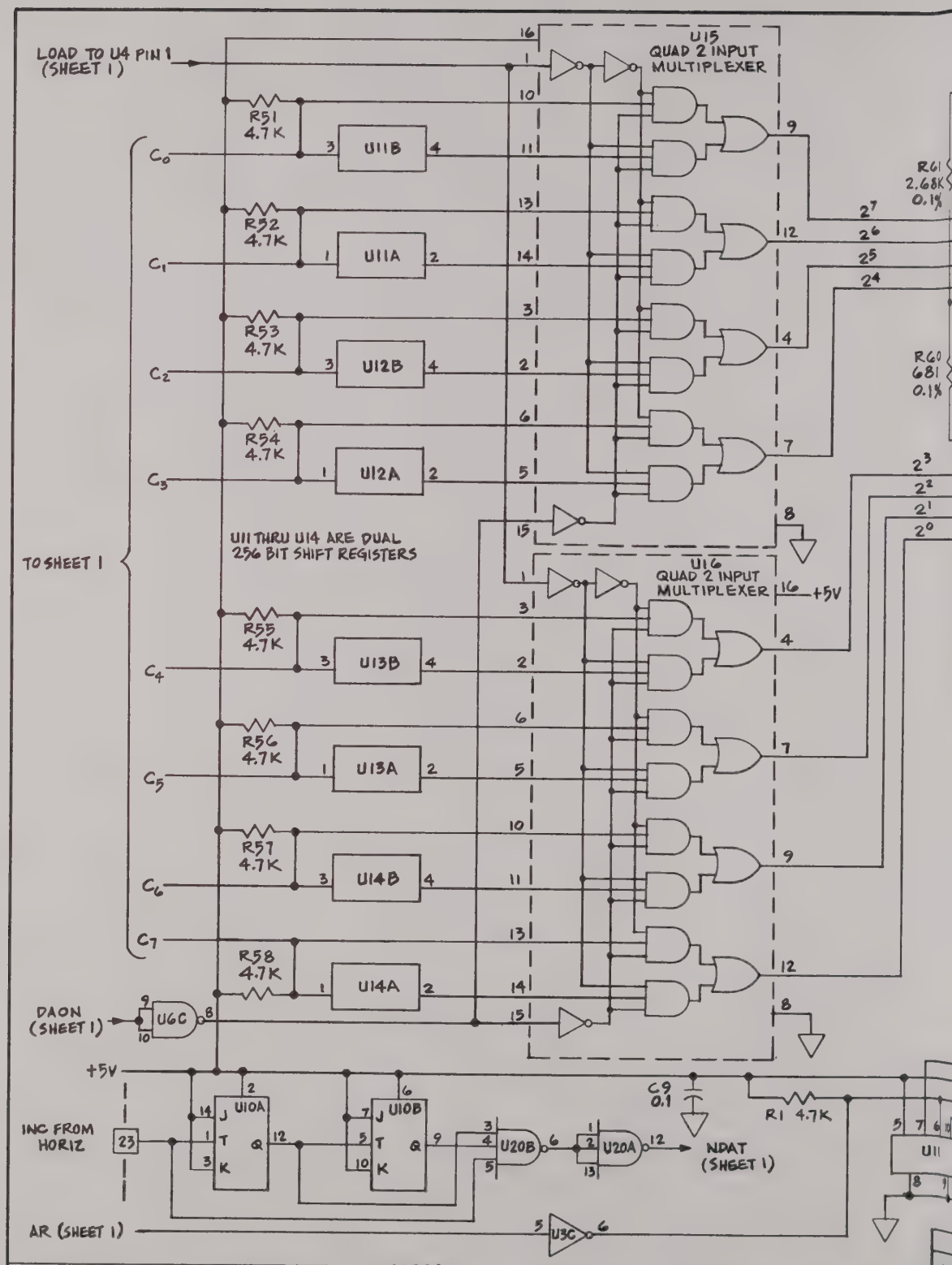


REF DESIG	I.C. TYPE
U7, U8	SN7474N
U5	710C
U4, U6 U9	SN7400N
U3	SN7404N
U2	9334
U1	SN7490N

NOTE

UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% ¼W. CAPACITOR VALUES ARE IN MICROFARADS.

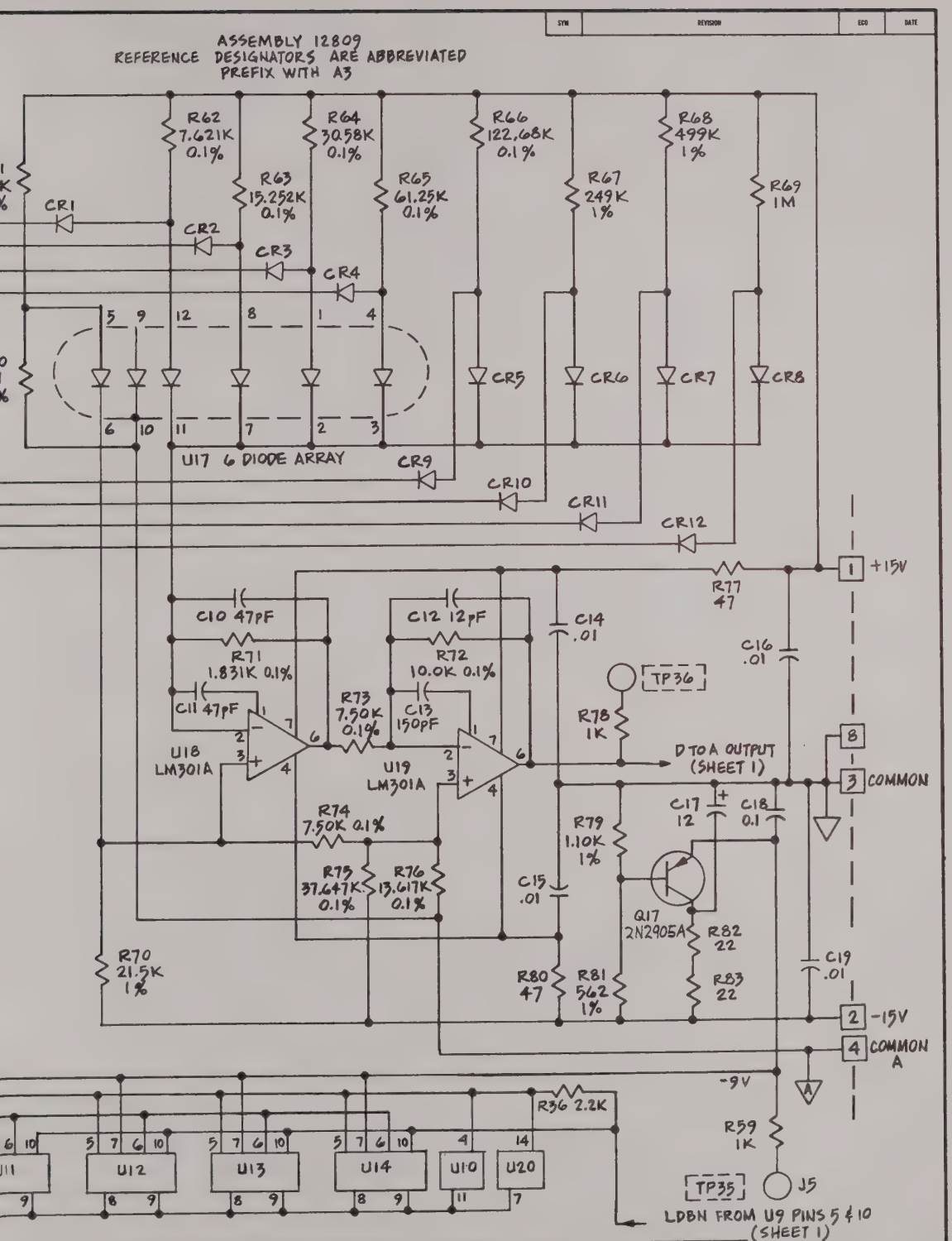

REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A3
SYM
REVISION
ECO
DATE
30 S1
29 S0
28 S2
5 CORRECTION OUT
+5V
U7A
U7B
U8A
U8B
R18 33K
R19 22K
R20 470K
Q4 2N4250
R21 33K
R22 22K
R23 470K
Q5 2N4250
R24 33K
R25 22K
R26 470K
Q6 2N4250
R27 33K
R28 22K
R29 470K
Q7 2N4250
Q8 2N4250
R30 33K
R31 22K
R32 470K
Q10 T1559
Q11 T1559
Q12 T1559
Q13 T1559
Q14 E112
R43 49.9K 1%
R44 12.7K 1%
R45 10.0K 1%
R46 255 1%
R47 4.64K 1%
R48 7.68K 1%
4 COMMON A
FROM D TO A (SHTS 2,3,4 & 5)
LOAD (S 2,3,4 & 5)
R37 2.2K
R38 3.3K
+5V
CR13 IN4148
Q9 2N4250
Q15 T1559
13 MEMORY OUT
R33 10K
R34 10K
R35 10K
U9C
U9D
U3B
U9A
U9B
R40 68K
R39 33K
R41 470K
R42 100K
Q16 2N3565
15 CONTROL A
-15V
20 LOAD
DAON (SHTS 2,3 & 5)
LDBN (SHTS 2,3 & 5)
C20 0.1
C21 0.1
C22 0.1
R84 470
R85 470
R86 470
25 STORE
27 MEMORY
26 INPUT MINUS MEMORY
ITEM
REQD
PART NO
DESCRIPTION
LIST OF MATERIAL
NEXT ASSY
FINISH OR TREATMENT
UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE
XX .01
XXX .005
SCALE
DRAWN YO
DATE 1-7-74
ENG RHB
2-6-74
PROD
PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO CALIFORNIA
MEMORY CIRCUIT
DRAWING NO. 12864
REV B
SHEET 1 OF 5

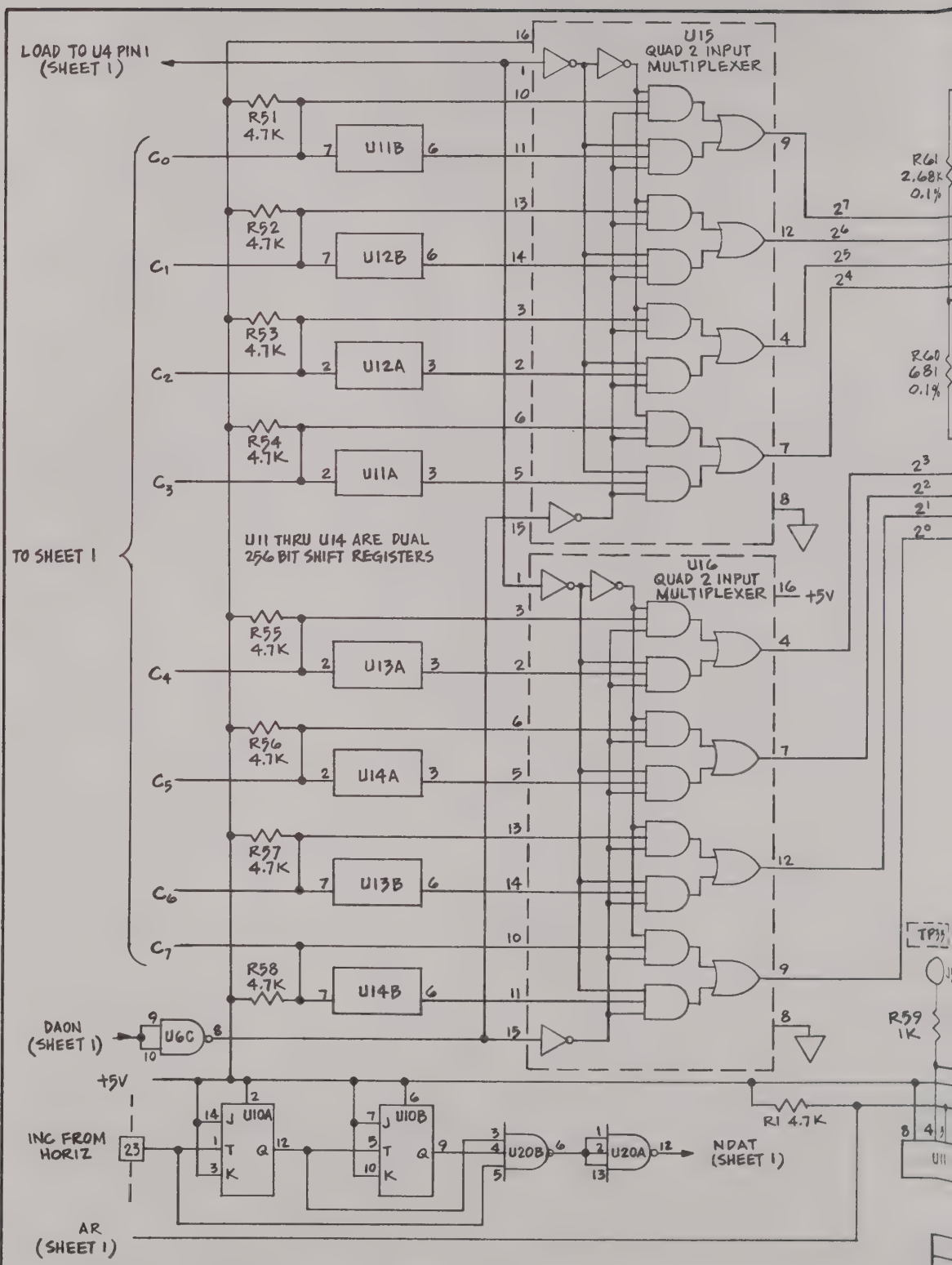


REF DESIG	I.C. TYPE
U10	SN7473N
U20	SN7410N
U18, U19	LM301A
U17	CA3039
U15, U16	F9322
U11, U12, U13, U14	MM5056

NOTES

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% ¼W. CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL DIODES ARE IN4148.


ASSEMBLY 12809
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A3
SYM
REVISION
ECO
DATE
R62 7.621K 0.1%
R63 15.252K 0.1%
R64 30.58K 0.1%
R65 61.25K 0.1%
R66 122.68K 0.1%
R67 249K 1%
R68 499K 1%
R69 1M
CR1
CR2
CR3
CR4
CR5
CR6
CR7
CR8
CR9
CR10
CR11
CR12
5 9 12 8 1 4
6 10 11 7 2 3
U17 6 DIODE ARRAY
R77 47
+15V
C10 47pF
C12 12pF
C14 .01
C16 .01
R71 1.831K 0.1%
R72 10.0K 0.1%
C11 47pF
R73 7.50K 0.1%
C13 150pF
TP36
R78 1K
U18 LM301A
U19 LM301A
D TO A OUTPUT (SHEET 1)
COMMON
R74 7.50K 0.1%
R79 1.10K 1%
C17 12
C18 0.1
R75 37.647K 0.1%
R76 13.617K 0.1%
C15 .01
Q17 2N2905A
R82 22
R83 22
C19 .01
R70 21.5K 1%
R80 47
R81 562 1%
-15V
COMMON A
-9V
R36 2.2K
R59 1K
U11
U12
U13
U14
U10
U20
TP35
J5
LDBN FROM U9 PINS 5 & 10 (SHEET 1)
ITEM
REQD
PART NO.
DESCRIPTION
NEXT ASSY
LIST OF MATERIAL
FINISH OR TREATMENT
UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE
SCALE
DRAWN
YO
1-17-74
ENG
RHB
2-6-74
PROD
PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO CALIFORNIA
MEMORY CIRCUIT – 256 BIT
DRAWING NO
12864
REV
SHEET 2 OF 5

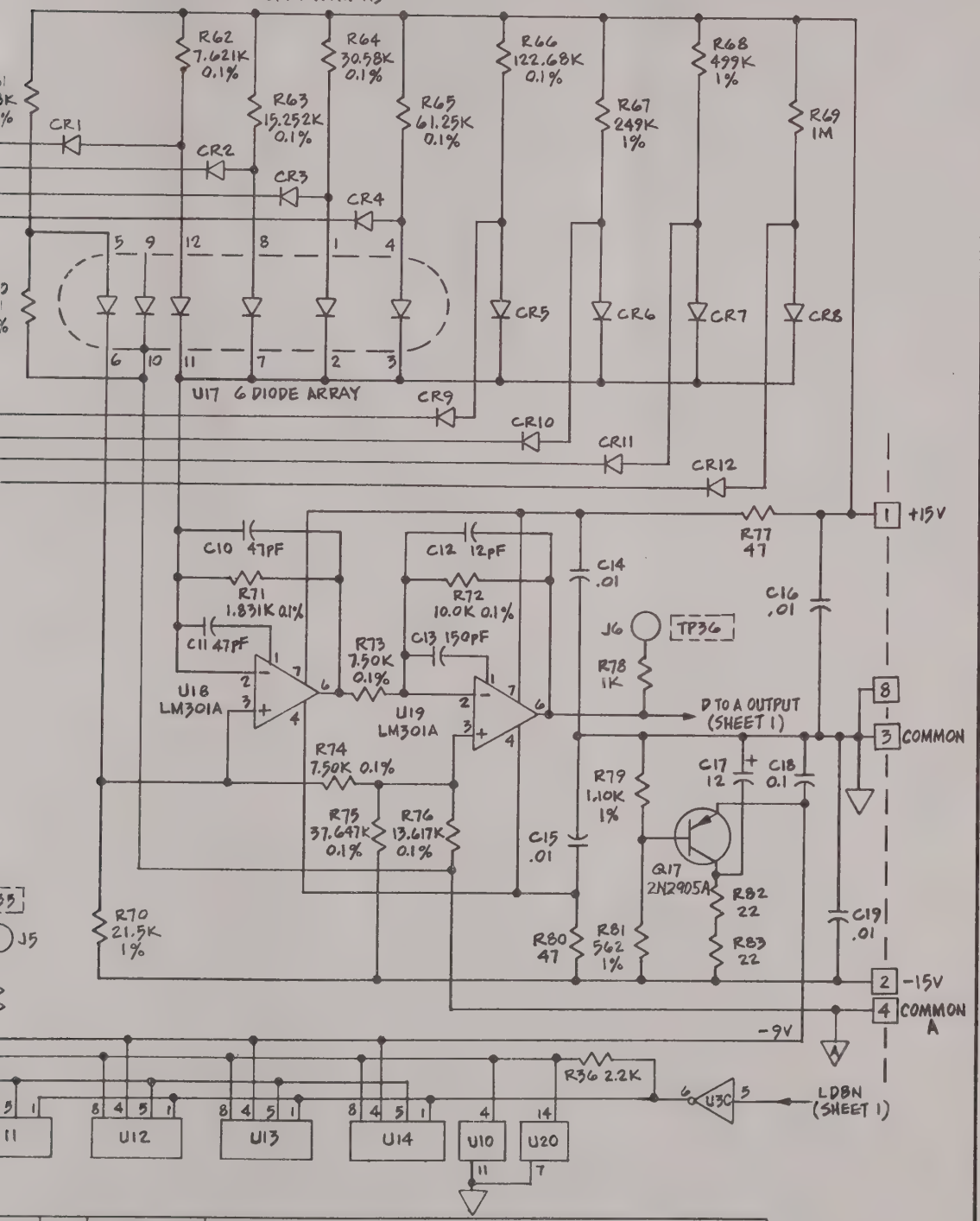


REF DESIG	I.C. TYPE
U20	SN7410N
U18, U19	LM301A
U17	CA3039
U15, U16	F9322
U11, U12, U13, U14	2527
U10	SN7473N

NOTES

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% ¼W. CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL DIODES ARE IN4148.

ASSEMBLY 12266
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A3



ITEM	REQD	PART NO	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE
.XX ±.15
.XXX ±.005

SCALE

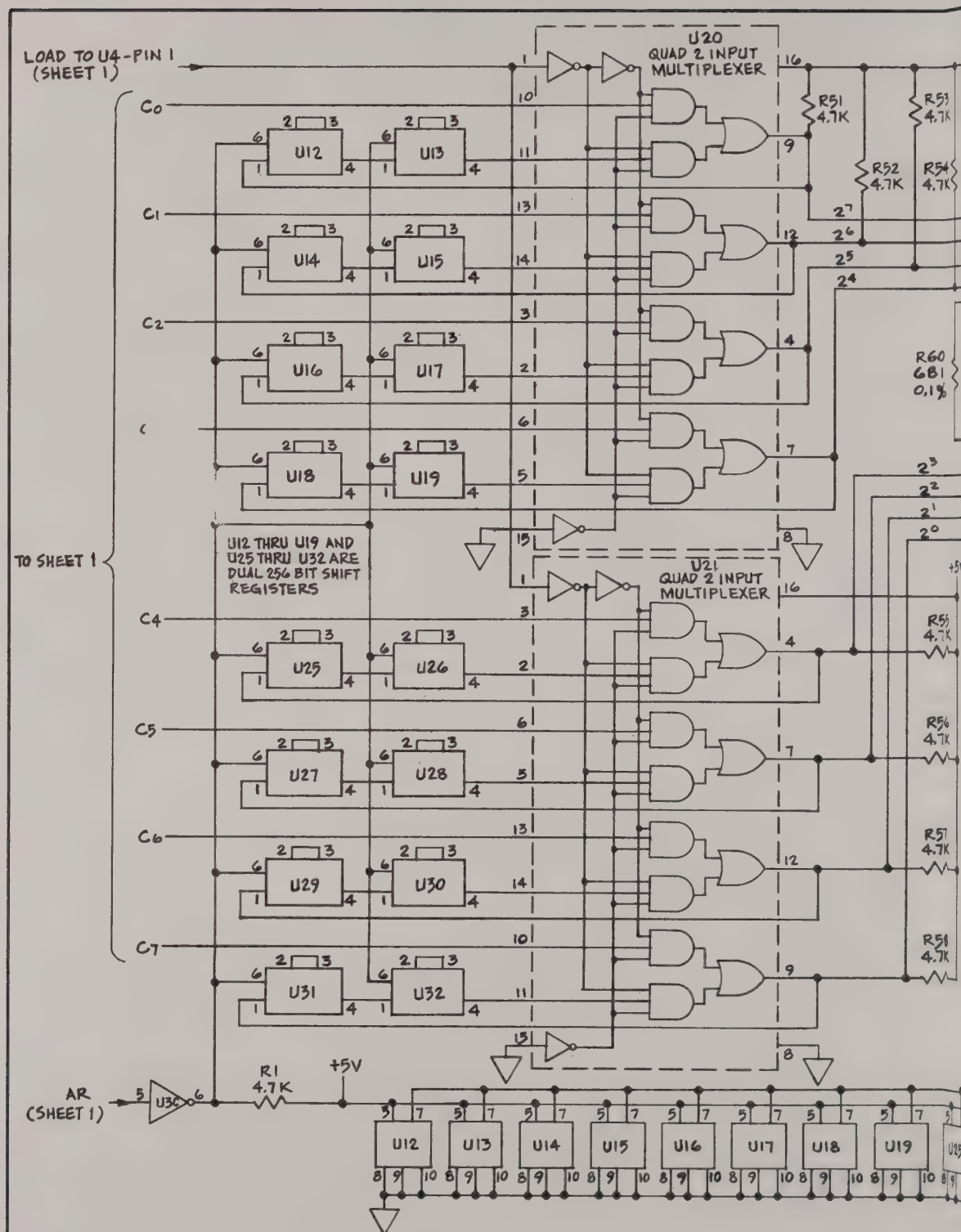
		DATE
DRAWN	YO	1-17-74
ENG	RHB	2-6-74
PROD		

PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

MEMORY CIRCUIT – 256 BIT

DRAWING NO. 12864 REV

SHEET 3 OF 5



REF DESIG	I.C. TYPE
U23, U24	LM301A
U22	CA3039
U20, U21	F9322
U12, U13, U14, U15, U16, U17, U18, U19, U25, U26, U27, U28, U29, U30, U31, U32	MM5056

NOTES
1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% ¼W. CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL DIODES ARE IN4148.

ASSEMBLY 12830
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A3

SYM	REVISION	ECO	DATE

+5V

R62 7.621K 0.1%
R64 30.58K 0.1%
R66 122.68K 0.1%
R68 499K 1%
R61 2.68K 0.1%
R63 15.252K 0.1%
R65 61.25K 0.1%
R67 249K 1%
R69 1M

CR1 CR2 CR3 CR4 CR5 CR6 CR7 CR8 CR9 CR10 CR11 CR12

5 9 12 8 1 4
6 10 11 7 2 3

U22 6 DIODE ARRAY

+5V

C10 47 PF
C12 12pF
C14 .01
C16 .01
R77 47
1 +15V

R71 1.831K 0.1%
R72 10.0K 0.1%
C11 47pF
C13 150pF
R73 7.50K 0.1%
J6 TP36
R78 1K

U23 LM301A
U24 LM301A

D TO A OUTPUT (SHEET 1)

8
3 COMMON

R74 7.50K 0.1%
R81 1.10K 1%
C17 12
C18 0.1

R75 37.647K 0.1%
R76 13.617K 0.1%
C15 .01
Q18 2N2905A
R82 22
C19 .01

R70 21.5K 1%
R80 47
R79 562 1%
R83 22

2 -15V
4 COMMON A

-9V

U25 U26 U27 U28 U29 U30 U31 U32

R59 1K
J5 TP35

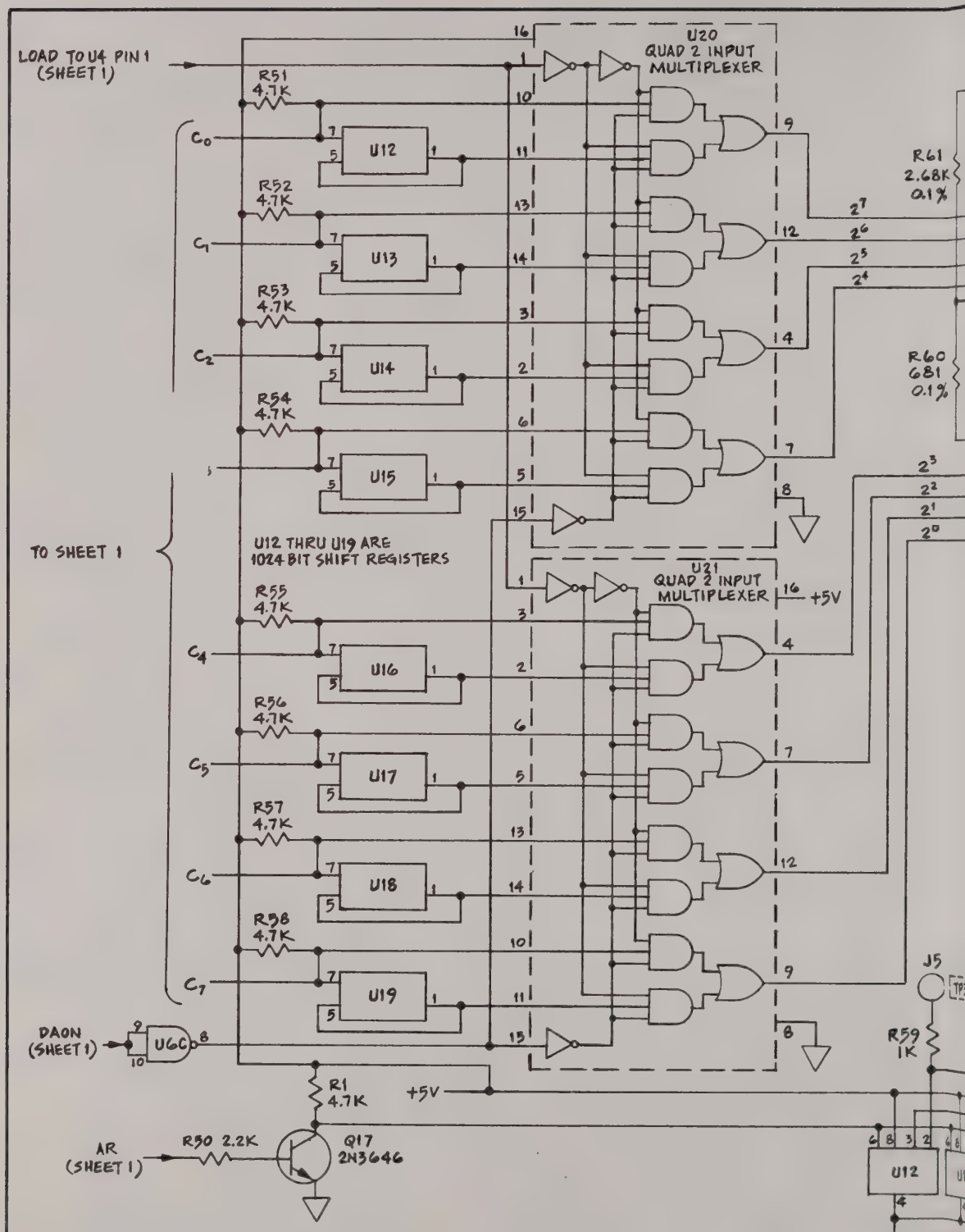
NDAT (SHEET 1)
23 INC FROM HORIZ

ITEM	REQD	PART NO.	DESCRIPTION

LIST OF MATERIAL

NEXT ASSY

FINISH OR TREATMENT	UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES TOLERANCE .XX ± .015 .XXX ± .005	DRAWN YO	1-8-74	PM PACIFIC MEASUREMENTS INCORPORATED PALO ALTO CALIFORNIA
		ENG RHB	2-6-74	MEMORY CIRCUIT - 1024 BIT
		PROD		DRAWING NO 12864 REV
	SCALE			SHEET 4 OF 5



REF DESIG	I.C. TYPE
U23, U24	LM301A
U22	CA3039
U20, U21	F9322
U12, U13, U14, U15 U16, U17, U18, U19	2533

NOTES

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS AND ARE ±5% ¼W. CAPACITOR VALUES ARE IN MICROFARADS.
2. ALL DIODES ARE 1N4148.

ASSEMBLY 12667
REFERENCE DESIGNATORS ARE ABBREVIATED
PREFIX WITH A3

SYM	REVISION	ECO	DATE

R62 7.621K 0.1%
R64 30.58K 0.1%
R66 122.68K 0.1%
R68 499K 1%
R63 15.252K 0.1%
R65 61.25K 0.1%
R67 249K 1%
R69 1M

CR1 CR2 CR3 CR4 CR5 CR6 CR7 CR8

5 9 12 8 1 4
6 10 11 7 2 3

U22 6 DIODE ARRAY

CR9 CR10 CR11 CR12

R77 47

1 +15V

C10 47PF
C12 12PF
C14 .01
C16 .01

R71 1.831K 0.1%
R72 10.0K 0.1%

C11 47PF
R73 7.50K 0.1%
C13 150PF

J6 TP36
R78 1K
D TO A OUTPUT (SHEET 1)

U23 LM301A
U24 LM301A

8
3 COMMON

R74 7.50K 0.1%
R81 1.47K 1%
C17 12
C18 .1

R75 37.647K 0.1%
R76 13.617K 0.1%
C15 .01

Q18 2N2905A
R82 15
R83 15
C19 .01

R80 47
R79 280 1%

R70 21.5K 1%
TP35

2 -15V
4 COMMON A

-12V

R36 2.2K
U3C
LDBN (SHEET 1)

U13 U14 U15 U16 U17 U18 U19

NDAT (SHEET 1)
23 INC FROM HORIZ

LIST OF MATERIAL

ITEM	MFGR	PART NO.	DESCRIPTION

NEXT ASSY

FINISH OR TREATMENT

UNLESS OTHERWISE INDICATED DIMENSIONS ARE IN INCHES
TOLERANCE
.XX ± .015
.XXX ± .005
SCALE

DRAWN	YO	1-17-74
ENG	RHB	2-6-74
PROD		

PM PACIFIC MEASUREMENTS INCORPORATED
PALO ALTO, CALIFORNIA

MEMORY CIRCUIT – 1024 BIT

DRAWING NO. 12864 REV B
SHEET 5 OF 5

SECTION 8

REPLACEABLE PARTS LIST

Reference Designator, Description and PM Part Number 8-2

PM Part Number Cross Reference to Original Manufacturer's Part Number 8-8

Federal Supply Codes for Manufacturers 8-10

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
		CHASSIS
		11527 (Model 1038-V10)
		12528 (Model 1038-V11)
		12727 (Model 1038-V12)
C1	10000-11	Ceramic .01 µF, ±20%, 100 V
J1	12564	Connector, 3 conductor audio
R1	13076	Variable 50KΩ 10 turns
R2	11676-1	Variable 100KΩ ±20% 1/2 W
R3	11676-1	Variable 100KΩ ±20% 1/2 W
S1	12479	Switch, Pushbutton, 7 station (For Models 1038-V11 and 1038-V12 only)
S1	12478	Switch, Pushbutton, 4 station (For Model 1038-V10 only)
S2	12479	Switch, Pushbutton, 7 station
S3	12475	Thumbwheel, 3 station
S4	12690	Switch, Rotary SP9T
S5	12483	Switch, Momentary SPST (For Models 1038-V11 and 1038-V12 only)
		DIGIT SWITCH PC BOARD ASSEMBLY - 12485
A1R1	10015-84	Metal Film 2.10 KΩ ±1% 1/8 W
A1R2	10015-47	Metal Film 2.49 KΩ ±1% 1/8 W
A1R3	10015-211	Metal Film 2.74 KΩ ±1% 1/8 W
A1R4	10015-79	Metal Film 2.67 KΩ ±1% 1/8 W
A1R5	10015-79	Metal Film 2.67 KΩ ±1% 1/8 W
A1R6	10015-211	Metal Film 2.74 KΩ ±1% 1/8 W
A1R7	10015-47	Metal Film 2.49 KΩ ±1% 1/8 W
A1R8	10015-84	Metal Film 2.10 KΩ ±1% 1/8 W
A1R9	10015-99	Metal Film 14.0 KΩ ±1% 1/8 W
A1R10	10015-65	Metal Film 4.99 KΩ ±1% 1/8 W
A1R11	10015-19	Metal Film 1.00 KΩ ±1% 1/8 W
A1R12	12449-16	Metal Film 150 KΩ ±0.1% 1/8 W
A1R13	12449-15	Metal Film 75.0 KΩ ±0.1% 1/8 W
A1R14	12449-14	Metal Film 37.5 KΩ ±0.1% 1/8 W
A1R15	12449-13	Metal Film 18.75 KΩ ±0.1% 1/8 W
A1R16	10015-191	Metal Film 66.5 KΩ ±1% 1/8 W
A1R17	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A1R18	12449-23	Metal Film 375.0 KΩ ±0.1% 1/8W
A1R19	12449-23	Metal Film 375.0 KΩ ±0.1% 1/8W
A1R20	12449-23	Metal Film 375.0 KΩ ±0.1% 1/8W
A1R21	12499-17	Metal Film 187.5 K ±0.1% 1/8 W
A1R22	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A1R23	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A1R24	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A1R25	10015-208	Metal Film 124 KΩ ±1% 1/8 W
		LOG AMPLIFIER PC BOARD ASSEMBLY - 12432
A2C1	10001-5	Ceramic 33 pF ±5% 1000 V
A2C2	10000-5	Ceramic .0022 µF ±5% 500 V
A2C3	10000-5	Ceramic .0022 µF ±5% 500 V
A2C4	10000-5	Ceramic .0022 µF ±5% 500 V
A2C5	10000-5	Ceramic .0022 µF ±5% 500 V
A2C6	11501-2	Ceramic 0.1 µF ±20% 50 V
A2C7	11501-2	Ceramic 0.1 µF ±20% 50 V
A2C8	10000-12	Ceramic 150 pF ±20% 1000 V
A2C9	10000-4	Ceramic .001µF ±20% 1000V
A2C10	10000-12	Ceramic 150 pF ±20% 1000 V
A2C11	10001-20	Ceramic 30pF ±5% 1000 V
A2C12	10000-8	Ceramic .02 µF ±20% 100 V
A2C13	10000-11	Ceramic .01 µF ±20% 100 V
A2C14	10000-11	Ceramic .01 µF ±20% 100 V
A2C15	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A2C16	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A2C17	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A2C18	10787-2	Tantalum 12 µF ±20% 15 V
A2C19	10787-2	Tantalum 12 µF ±20% 15 V
A2C20	10787-3	Tantalum 27 µF ±20% 25 V
A2C21	10787-3	Tantalum 27 µF ±20% 25 V
A2C22	10787-3	Tantalum 27 µF ±20% 25 V
A2C23	10787-3	Tantalum 27 µF ±20% 25 V
A2C24	10787-2	Tantalum 12 µF ±20% 15 V
A2C25	10787-2	Tantalum 12 µF ±20% 15 V
A2C26	--	Not Used
A2C27	--	Not Used
A2C28	--	Not Used
A2C29	10007-7	Mylar 0.1 µF ±10% 200 V
A2C30	10007-5	Mylar .022 µF ±10% 200 V
A2C31	10000-11	Ceramic .01 µF ±20% 100 V
A2C32	10000-11	Ceramic .01 µF ±20% 100 V
A2C33	10000-1	Ceramic 100 pF ±20% 1000 V
A2C34	10000-4	Ceramic .001 µF ±20% 1000 V
A2C35	10000-11	Ceramic .01 µF ±20% 100 V
A2C36	10000-11	Ceramic .01 µF ±20% 100 V
A2C37	10007-1	Mylar .001 µF ±10% 200 V
A2C38	10787-5	Tantalum 1.0 µF ±20% 15V
A2C39	10000-12	Ceramic 150 pF ±20% 1000 V
A2C40	10000-11	Ceramic .01 µF ±20% 100 V
A2C41	10000-11	Ceramic .01 µF ±20% 100 V
A2C42	10133-3	Ceramic 1.0 pF ±.25 pF 500 V
A2C43	10007-5	Mylar .022 µF ±10% 200 V
A2C44	10787-4	Tantalum 68 µF ±20% 15 V
A2C45	10007-9	Mylar .47 µF ±10% 200 V
A2C46	10000-11	Ceramic .01 µF ±20% 100 V
A2C47	10000-11	Ceramic .01 µF ±20% 100 V
A2C48	10001-5	Ceramic 33 pF ±5% 1000 V
A2C49	10000-2	Ceramic 220pF ± 20% 1000V
A2C50	10007-2	Mylar .0022 µF ± 10 % 200 V
A2C51	10000-3	Ceramic 470 pF ±20% 1000 V
A2C52	10000-11	Ceramic .01 µF ±20% 100 V
A2C53	10000-11	Ceramic .01 µF ±20% 100 V
A2C54	10000-6	Ceramic .0047 µF ±20% 500 V
A2C55	10000-11	Ceramic .01 µF ±20% 100 V
A2C56	10000-11	Ceramic .01 µF ±20% 100 V
A2C57	11501-4	Ceramic 1.0 pF ± 10% 100 V
A2C58	--	Not Used
A2C59	10677-18	Mica 1000pF ±5% 100V
A2C60	10007-7	Mylar 0.1 µF ±10% 200 V
A2C61	10677-18	Mica 1000pF ±5% 100V
A2C62	10007-7	Mylar 0.1 µF ±10% 200 V
A2C63	--	Factory Select
A2C64	10007-7	Mylar 0.1 µF ±10% 200 V
A2C65	10007-7	Mylar 0.1 µF ±10% 200 V
A2C66	10000-2	Ceramic 220 pF ±20% 1000 V
A2C67	10001-3	Ceramic 10 pF ±5% 1000 V
A2C68	10000-11	Ceramic .01 µF ±20% 100 V
A2C69	10000-11	Ceramic .01 µF ±20% 100 V
A2C70	10909-4	Mica .0024 µF ±1% 500 V
A2C71	10909-4	Mica .0024 µF ±1% 500 V
A2C72	10909-5	Mica .0047 µF ±1% 500 V
A2C73	10007-5	Mylar .022 µF ±10% 200 V
A2C74	10007-6	Mylar .047 µF ±10% 200 V
A2C75	10787-3	Tantalum 27 µF ±20% 15 V
A2C76	10000-6	Ceramic .0047 µF ±20% 500 V
A2C77	10909-5	Mica .0047 µF ±1% 500 V
A2C78	10011-2	Mylar 1.0 µF ±10% 100 V
A2C79	10011-2	Mylar 1.0 µF ±10% 100 V
A2C80	11501-2	Ceramic 0.1 µF ±20% 50 V
A2C81	11501-2	Ceramic 0.1 µF ±20% 50 V

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2C82	10000-6	Ceramic .0047 µF ±20% 500 V
A2C83	10000-4	Ceramic .001 µF ±20% 1000 V
A2C84	10000-6	Ceramic .0047 µF ±20% 500 V
A2C85	10000-1	Ceramic 100 pF ±20% 1000 V
A2C86	10001-2	Ceramic 4.7 pF ±5% 1000 V
A2C87	10001-2	Ceramic 4.7 pF ±5% 1000 V
A2C88	10630-1	Variable Ceramic NPO 2-8 pF
A2C89	10000-2	Ceramic 220 pF ± 20% 1000 V
A2CR1	10043	1N4148
A2CR2	10043	1N4148
A2CR3	11715	1N4446
A2CR4	11715	1N4446
A2CR5	11715	1N4446
A2CR6	11715	1N4446
A2CR7	10045	1N823
A2CR8	10045	1N823
A2CR9	10043	1N4148
A2CR10	10043	1N4148
A2CR11	10043	1N4148
A2CR12	10043	1N4148
A2CR13	--	Not Used
A2CR14	--	Not Used
A2CR15	10043	1N4148
A2F1	13503-1	Fuse 0.5A 250 V
A2J1	10140-1	Test Jack, Red
A2J2	10140-2	Test Jack, Yellow
A2J3	10140-3	Test Jack, Black
A2J4	10140-2	Test Jack, Yellow
A2J5	10140-1	Test Jack, Red
A2J6	10140-4	Test Jack, Blue
A2J7	10140-2	Test Jack, Yellow
A2J8	10140-2	Test Jack, Yellow
A2J9	10140-3	Test Jack, Black
A2J10	10140-2	Test Jack, Yellow
A2J11	10140-2	Test Jack, Yellow
A2J12	--	Not Used
A2J13	10140-2	Test Jack, Yellow
A2L1	10920-1	Coil, RF 100 µH ±10%
A2Q1	12799	E 109 (Siliconix)
A2Q2	11119	2N4250
A2Q3	12799	E109 (Siliconix)
A2Q4	12591	E112 (Siliconix)
A2Q5	12799	E109 (Siliconix)
A2Q6	10019	2N3565
A2Q7	11119	2N4250
A2Q8	11585	T1S59 (TI)
A2Q9	11119	2N4250
A2Q10	11119	2N4250
A2Q11	11119	2N4250
A2Q12	11507	T1S97 (TI)
A2Q13	12439	2N5785
A2Q14	10206	2N3053
A2Q15	10206	2N3053
A2Q16	10896	*MFE 3004 or 3N138
A2Q17	10896	* MFE 3004 or 3N138
A2Q18	11432	FM3955 (National Semiconductor)
A2Q19	13533	2N2907
A2Q20	10018	2N3646
A2Q21	13534	2N2221/2N2221 A
A2Q22	11585	T1S59 (TI)
A2Q23	10018	2N3646
A2Q24	13533	2N2907
A2Q25	11585	T1S59 (TI)
A2Q26	12474	FCD-810 (Fairchild)
A2Q27	--	Not Used
A2Q28	--	Not Used
A2Q29	10896	*MFE 3004 or 3N138
A2Q30	10896	* MFE 3004 or 3N138
A2Q31	11119	2N4250
A2Q32	11507	T1S97 (TI)
A2Q33	11507	T1S97 (TI)
A2Q34	10019	2N3565
A2Q35	10019	2N3565
A2R1	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A2R2	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A2R3	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A2R4	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R5	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A2R6	10046-1	Variable Comp 500 Ω ±20% 1/4 W
A2R7	10015-7	Metal Film 10.0 KΩ ±1% 1/8 W
A2R8	12449-22	Metal Film 2.50 KΩ ±0.1 % 1/8 W
A2R9	12449-21	Metal Film 10.0 KΩ ±0.1 % 1/8 W
A2R10	12449-22	Metal Film 2.50 KΩ ±0.1 % 1/8 W
A2R11	12449-18	Metal Film 7.50 KΩ ±0.1 % 1/8 W
A2R12	12449-18	Metal Film 7.50 KΩ ±0.1 % 1/8 W
A2R13	10015-90	Metal Film 24.9 KΩ ±1% 1/8 W
A2R14	10015-133	Metal Film 49.9 KΩ ±1% 1/8 W
A2R15	10013-57	Carbon Film 470 K ±5% 1/4 W
A2R16	10013-57	Carbon Film 470 K ±5% 1/4 W
A2R17	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A2R18	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R19	10013-47	Carbon Film 68 KΩ ±5% 1/4 W
A2R20	10015-213	Metal Film 178 KΩ ±1% 1/8 W
A2R21	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R22	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R23	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R24	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R25	12449-21	Metal Film 10.0 KΩ ±0.1% 1/8 W
A2R26	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R27	10015-207	Metal Film 20.0 KΩ ±1% 1/8 W
A2R28	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R29	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R30	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A2R31	10015-207	Metal Film 20.0 KΩ ±1% 1/8 W
A2R32	10015-47	Metal Film 2.49 KΩ ±1% 1/8 W
A2R33	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R34	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R35	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R36	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R37	10015-7	Metal Film 10.0 KΩ ±1% 1/8 W
A2R38	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R39	10015-20	Metal Film 1.10 KΩ ±1% 1/8 W
A2R40	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A2R41	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R42	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R43	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R44	10015-159	Metal Film 402 Ω ±1% 1/8 W
A2R45	10015-116	Metal Film 30.1 KΩ ±1% 1/8 W
A2R46	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R47	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R48	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R49	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R50	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R51	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R52	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R53	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R54	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R55	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R56	10015-28	Metal Film 23.7 KΩ ±1% 1/8 W
A2R57	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A2R58	10013-51	Carbon Film 150 K Ω ± 5% 1/4 W

*Must come all from same mfr.

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2R59	10013-39	Carbon Film 15 KΩ ±5% 1/4 W
A2R60	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A2R61	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R62	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A2R63	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A2R64	10013-47	Carbon Film 68 KΩ ±5% 1/4 W
A2R65	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R66	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R67	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R68	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R69	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R70	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A2R71	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A2R72	13300-3	Variable Cermet 20KΩ ±20% 1/2W
A2R73	10015-143	Metal Film 71.5 Ω ±1% 1/8 W
A2R74	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R75	10015-133	Metal Film 49.9 KΩ ±1% 1/8 W
A2R76	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R77	10013-1	Carbon Film 10 Ω ±5% 1/4 W
A2R78	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R79	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R80	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R81	10015-183	Metal Film 80.6 KΩ ±1% 1/8 W
A2R82	10015-183	Metal Film 80.6 KΩ ±1% 1/8 W
A2R83	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R84	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R85	10046-8	Variable Comp 10 KΩ ±20% 1/4 W
A2R86	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A2R87	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R88	10015-65	Metal Film 4.99 KΩ ±1% 1/8 W
A2R89	11711-3	Variable Comp 20 KΩ ±20% 1/4 W
A2R90	10015-213	Metal Film 178 KΩ ±1% 1/8 W
A2R91	--	Factory Selected
A2R92	10015-170	Metal Film 348 Ω ±1% 1/8 W
A2R93	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A2R94	10046-1	Variable Comp 500 Ω ±20% 1/4 W
A2R95	10015-58	Metal Film 9.76 KΩ ±1% 1/8 W
A2R96	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R97	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R98	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A2R99	10015-209	Metal Film 130 KΩ ±1% 1/8 W
A2R100	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R101	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R102	10013-11	Carbon Film 68 Ω ±5% 1/4 W
A2R103	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R104	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R105	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R106	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R107	10013-55	Carbon Film 330 KΩ ±5% 1/4 W
A2R108	10013-55	Carbon Film 330 KΩ ±5% 1/4 W
A2R109	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R110	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R111	10015-31	Metal Film 3.16 KΩ ±1% 1/8 W
A2R112	10015-71	Metal Film 909 Ω ±1% 1/8 W
A2R113	10015-73	Metal Film 10.2 KΩ ±1% 1/8 W
A2R114	10015-99	Metal Film 14.0 KΩ ±1% 1/8 W
A2R115	10015-7	Metal Film 10.0 KΩ ±1% 1/8 W
A2R116	-----	Factory Selected
A2R117	10015-13	Metal Film 100 KΩ ±1% 1/8 W
A2R118	10015-19	Metal Film 1.00 KΩ ±1% 1/8 W
A2R119	10015-96	Metal Film 12.1 KΩ ±1% 1/8 W
A2R120	10015-63	Metal Film 402 KΩ ±1% 1/8 W
A2R121	10015-85	Metal Film 287 KΩ ±1% 1/8 W
A2R122	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R123	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R124	10013-19	Carbon Film 330 Ω ±5% 1/4 W
A2R125	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R126	10015-120	Metal Film 69.8 KΩ ±1% 1/8 W
A2R127	10015-191	Metal Film 66.5 KΩ ±1% 1/8 W
A2R128	10015-191	Metal Film 66.5 KΩ ±1% 1/8 W
A2R129	10015-191	Metal Film 66.5 KΩ ±1% 1/8 W
A2R130	10013-61	Carbon Film 1 MΩ ±1% 1/4 W
A2R131	10013-37	Carbon Film 10KΩ ± 5% 1/4W
A2R132	10013-57	Carbon Film 470KΩ ±5% 1/4W
A2R133	10015-16	Metal Film 18.7 KΩ ±1% 1/8W
A2R134	10015-13	Metal Film 100 KΩ± 1% 1/8W
A2R135	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R136	10013-73	Carbon Film 10 MΩ ±5% 1/4 W
A2R137	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R138	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R139	10015-61	Metal Film 39.2 KΩ ±1% 1/8 W
A2R140	--	Not Used
A2R141	10015-61	Metal Film 39.2 KΩ ±1% 1/8 W
A2R142	--	Not Used
A2R143	10013-51	Carbon Film 150 KΩ ±1% 1/4 W
A2R144	10013-51	Carbon Film 150 KΩ ±1% 1/4 W
A2R145	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A2R146	10015-91	Metal Film 90.9 KΩ ±1% 1/8 W
A2R147	10015-91	Metal Film 90.9 KΩ ±1% 1/8 W
A2R148	10015-32	Metal Film 3.83 KΩ ±1% 1/8 W
A2R149	10013-27	Carbon Film 1.5 KΩ ±5% 1/4 W
A2R150	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R151	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R152	10142-2	Carbon Film 15 MΩ ±5% 1/4 W
A2R153	10013-59	Carbon Film 680 KΩ ±5% 1/4 W
A2R154	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R155	10015-84	Metal Film 2.10 KΩ ±1% 1/8 W
A2R156	10015-191	Metal Film 66.5 KΩ ±1% 1/8 W
A2R157	10015-191	Metal Film 66.5 KΩ ±1% 1/8 W
A2R158	10015-188	Metal Film 33.2 KΩ ±1% 1/8 W
A2R159	10015-22	Metal Film 10.7 KΩ ±1% 1/8 W
A2R160	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R161	10015-41	Metal Film 48.7 KΩ ±1% 1/8 W
A2R162	10015-22	Metal Film 10.7 K ±1% 1/8 W
A2R163	10046-13	Variable Comp 1 MΩ ±20% 1/4 W
A2R164	10015-54	Metal Film 110KΩ ±1% 1/8 W
A2R165	10015-179	Metal Film 140KΩ ±1% 1/8 W
A2R166	----	Factory Selected
A2R167	10015-32	Metal Film 3.83 KΩ ±1% 1/8 W
A2R168	10015-80	Metal Film 4.02 KΩ ±1% 1/8 W
A2R169	10015-40	Metal Film 43.2 KΩ ±1% 1/8 W
A2R170	10015-80	Metal Film 4.02 KΩ ±1% 1/8 W
A2R171	10015-25	Metal Film 61.9 KΩ ±1% 1/8 W
A2R172	10015-25	Metal Film 61.9 KΩ ±1% 1/8 W
A2R173	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R174	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A2R175	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R176	10015-80	Metal Film 4.02 KΩ ±1% 1/8W
A2R177	10015-158	Metal Film 392Ω ±1% 1/8W
A2R178	10013-53	Carbon Film 220 KΩ ±5% 1/4 W
A2R179	10015-70	Metal Film 681 Ω ±1% 1/8 W
A2R180	10015-133	Metal Film 49.9 KΩ ±1% 1/8 W
A2R181	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A2R182	10013-53	Carbon Film 220K Ω ± 5% 1/4 W
A2R183	10015-158	Metal Film 392Ω ± 1% 1/8 W
A2R184	10015-159	Metal Film 402 Ω ±1% 1/8 W
A2R185	10015-80	Metal Film 4.02 KΩ ±1% 1/8 W
A2R186	10046-6	Variable Comp 200 Ω ±20% 1/4 W
A2R187	10013-61	Carbon Film 1M Ω ±5% 1/4 W
A2R188	10013-61	Carbon Film 1M Ω ±5% 1/4 W
A2R189	10013-55	Carbon Film 330 KΩ ±5% 1/4 W
A2R190	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R191	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A2R192	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R193	10013-17	Carbon Film 220 Ω ±5% 1/4 W
A2R194	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A2R195	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A2R196	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A2R197	10015-80	Metal Film 4.02 KΩ ±1% 1/8 W

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A2RT1	10209	Thermistor
A2T1	12468	Transformer
A2T2	12260	Transformer, Transistor
A2U1	11627	LM301A (National Semiconductor)
A2U2	11627	LM301A (National Semiconductor)
A2U3	11627	LM301A (National Semiconductor)
A2U4	11539	SN72741L
A2U5	11270-1	SN7400N
A2U6	11539	SN72741L
A2U7	11539	SN72741L
A2U8	11539	SN72741L
A2U9	11627	LM301A (National Semiconductor)
A2U10	11627	LM301A (National Semiconductor)
A2U11	11539	SN72741L
A2U12	11539	SN72741L
A2U13	10769	709C
A2U14	11117	CA3026 (RCA)
A2U15	12445	725C
		MEMORY CIRCUIT PC BOARD ASSEMBLY (256 Bit) 12266 & 12809 (For Model 1038-V11 Only)
A3C1	10787-2	Tantalum 12 µF ±20% 15 V
A3C2	10000-2	Ceramic 220 pF ±20% 1000 V
A3C3	10000-11	Ceramic .01 µF ±20% 100 V
A3C4	10000-11	Ceramic .01 µF ±20% 100 V
A3C5	10000-2	Ceramic 220 pF ±20% 1000 V
A3C6	10000-11	Ceramic .01 µF ±20% 100 V
A3C7	10000-3	Ceramic 470 pF ±20% 1000 V
A3C8	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A3C9	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A3C10	10001-6	Ceramic 47 pF ±5% 1000 V
A3C11	10001-6	Ceramic 47 pF ±5% 1000 V
A3C12	10001-13	Ceramic 12 pF ±5% 1000 V
A3C13	10000-12	Ceramic 150 pF ±20% 1000 V
A3C14	10000-11	Ceramic .01 µF ±20% 100 V
A3C15	10000-11	Ceramic .01 µF ±20% 100 V
A3C16	10000-11	Ceramic .01 µF ±20% 100 V
A3C17	10787-2	Tantalum 12 µF ±20% 15 V
A3C18	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A3C19	10000-11	Ceramic .01 µF ±20% 100 V
A3C20	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A3C21	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A3C22	10000-10	Ceramic 0.1 µF +80% -20% 100 V
A3CR1 thru A3CR13	10043	1N4148
A3J1	10140-1	Test Jack, Red
A3J2	10140-2	Test Jack, Yellow
A3J3	10140-2	Test Jack, Yellow
A3J4	10140-3	Test Jack, Black
A3J5	10140-2	Test Jack, Yellow
A3J6	10140-2	Test Jack, Yellow
A3J7	10140-2	Test Jack, Yellow
A3Q1	10019	2N3565
A3Q2	11119	2N4250
A3Q3	10018	2N3646
A3Q4	11119	2N4250
A3Q5	11119	2N4250
A3Q6	11119	2N4250
A3Q7	11119	2N4250
A3Q8	11119	2N4250
A3Q9	11119	2N4250
A3Q10	11585	T1S59 (TI)
A3Q11	11585	T1S59 (TI)
A3Q12	11585	T1S59 (TI)
A3Q13	11585	T1S59 (TI)
A3Q14	12591	E112 (Siliconix)
A3Q15	11585	T1S59 (TI)
A3Q16	10019	2N3565
A3Q17	12942	2N2905A
A3R1	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R2	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R3	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R4	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R5	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R6	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R7	10013-51	Carbon Film 150 KΩ ±5% 1/4 W
A3R8	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A3R9	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R10	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R11	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A3R12	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R13	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R14	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R15	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R16	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A3R17	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R18	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R19	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R20	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R21	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R22	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R23	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R24	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R25	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R26	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R27	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R28	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R29	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R30	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R31	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R32	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R33	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R34	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R35	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R36	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R37	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R38	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A3R39	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R40	10013-47	Carbon Film 68 KΩ ±5% 1/4 W
A3R41	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R42	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A3R43	10015-133	Metal Film 49.9 KΩ ±1% 1/8 W
A3R44	10015-97	Metal Film 12.7 KΩ ±1% 1/8 W
A3R45	10015-7	Metal Film 10.0 KΩ ±1% 1/8 W
A3R46	10015-44	Metal Film 255 Ω ±1% 1/8 W
A3R47	10015-21	Metal Film 4.64 KΩ ±1% 1/8 W
A3R48	10015-30	Metal Film 7.68 KΩ ±1% 1/8 W
A3R49	10013-25	Carbon Film 1 KΩ ±1% 1/4 W
A3R50	--	Not Used
A3R51	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R52	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R53	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R54	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A3R55	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R56	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R57	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R58	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R59	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R60	12449-2	Metal Film 681 Ω ±0.1% 1/8 W
A3R61	12449-4	Metal Film 2.681 KΩ ±0.1% 1/8 W
A3R62	12449-5	Metal Film 7.621 KΩ ±0.1% 1/8 W
A3R63	12449-7	Metal Film 15.252 KΩ ±0.1% 1/8 W
A3R64	12449-8	Metal Film 30.58 KΩ ±0.1% 1/8 W
A3R65	12449-10	Metal Film 61.25 KΩ ±0.1% 1/8 W
A3R66	12449-12	Metal Film 122.68 KΩ ±0.1% 1/8 W
A3R67	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A3R68	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A3R69	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A3R70	10015-15	Metal Film 21.5 KΩ ±1% 1/8 W
A3R71	12449-3	Metal Film 1.831 KΩ ±0.1% 1/8 W
A3R72	12449-21	Metal Film 10.0 KΩ ±0.1% 1/8 W
A3R73	12449-18	Metal Film 7.50 KΩ ±0.1% 1/8 W
A3R74	12449-18	Metal Film 7.50 KΩ ±0.1% 1/8 W
A3R75	12449-9	Metal Film 37.647 KΩ ±0.1% 1/8 W
A3R76	12449-6	Metal Film 13.617 KΩ ±0.1% 1/8 W
A3R77	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A3R78	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R79	10015-20	Metal Film 1.10 KΩ ±1% 1/8 W
A3R80	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A3R81	10015-93	Metal Film 562 Ω ±1% 1/8 W
A3R82	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A3R82	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A3R83	10013-5	Carbon Film 22 Ω ±5% 1/4 W
A3R84	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A3R85	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A3R86	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A3R87	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3U1	11270-10	SN7490N
A3U2	12448	F9334 (Fairchild)
A3U3	11270-2	SN7404N
A3U4	11270-1	SN7400N
A3U5	11230	710C
A3U6	11270-1	SN7400N
A3U7	11270-16	SN7474N
A3U8	11270-16	SN7474N
A3U9	11270-1	SN7400N
A3U10	11270-8	SN7473N
A3U11 thru A3U14	12446	2527 (Signetics) Assy 12266 Only
A3U11 thru A3U14	12822	MM5056H (National Semiconductor) Assy 12809 Only
A3U15	12447	F9322 (Fairchild)
A3U16	12447	F9322 (Fairchild)
A3U17	11118	CA3039 (RCA)
A3U18	11627	LM301A (National Semiconductor)
A3U19	11627	LM301A (National Semiconductor)
A3U20	11270-15	SN7410N
		MEMORY CIRCUIT PC BOARD ASSEMBLY (1024 Bit) 12667 & 12830 (For Model 1038-V12 only)
A3C1	10787-2	Tantalum 12 µF ±20% 15 V
A3C2	10000-2	Ceramic 220 pF ±20% 1000 V
A3C3	10000-11	Ceramic .01 µF ±20% 100 V
A3C4	10000-11	Ceramic .01 µF ±20% 100 V
A3C5	10000-2	Ceramic 220 pF ±20% 1000 V
A3C6	10000-11	Ceramic .01 µF ±20% 100 V
A3C7	10000-3	Ceramic 470 pF ±20% 1000 V
A3C8	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A3C9	--	Not Used
A3C10	10001-6	Ceramic 47 pF ±5% 1000 V
A3C11	10001-6	Ceramic 47 pF ±5% 1000 V
A3C12	10001-13	Ceramic 12 pF ±5% 1000 V
A3C13	10000-12	Ceramic 150 pF ±20% 1000 V
A3C14	10000-11	Ceramic .01 µF ±20% 100 V
A3C15	10000-11	Ceramic .01 µF ±20% 100 V
A3C16	10000-11	Ceramic .01 µF ±20% 100 V
A3C17	10787-2	Tantalum 12 µF ±20% 15 V
A3C18	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A3C19	10000-11	Ceramic .01 µF ±20% 100 V
A3C20	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A3C21	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A3C22	10000-10	Ceramic 0.1 µF +80%-20% 100 V
A3CR1 thru A3CR13	10043	1N4148
A3J1	10140-1	Test Jack, Red
A3J2	10140-2	Test Jack, Yellow
A3J3	10140-2	Test Jack, Yellow
A3J4	10140-3	Test Jack, Black
A3J5	10140-2	Test Jack, Yellow
A3J6	10140-2	Test Jack, Yellow
A3J7	10140-2	Test Jack, Yellow
A3Q1	10019	2N3565
A3Q2	11119	2N4250
A3Q3	10018	2N3646
A3Q4	11119	2N4250
A3Q5	11119	2N4250
A3Q6	11119	2N4250
A3Q7	11119	2N4250
A3Q8	11119	2N4250
A3Q9	11119	2N4250
A3Q10	11585	T1S59 (TI)
A3Q11	11585	T1S59 (TI)
A3Q12	11585	T1S59 (TI)
A3Q13	11585	T1S59 (TI)
A3Q14	12591	E112 (Siliconix)
A3Q15	11585	T1S59 (TI)
A3Q16	10019	2N3565
A3Q17	10018	2N3646 (Assembly 12667)
A3Q17	--	Not Used (Assembly 12830)
A3Q18	12942	2N2905A (Assembly 12667)
A3Q18	12942	2N2905A (Assembly 12830)
A3R1	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R2	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R3	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R4	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R5	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R6	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R7	10013-51	Carbon Film 150 KΩ ±5% 1/4 W
A3R8	10046-10	Variable Comp 100 KΩ ±20% 1/4 W
A3R9	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R10	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R11	10013-35	Carbon Film 6.8 KΩ ±5% 1/4 W
A3R12	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R13	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R14	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R15	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W

CIRCUIT REFERENCE	PM PART NO.	DESCRIPTION
A3R16	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A3R17	10013-13	Carbon Film 100 Ω ±5% 1/4 W
A3R18	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R19	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R20	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R21	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R22	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R23	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R24	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R25	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R26	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R27	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R28	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R29	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R30	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R31	10013-41	Carbon Film 22 KΩ ±5% 1/4 W
A3R32	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R33	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R34	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R35	10013-37	Carbon Film 10 KΩ ±5% 1/4 W
A3R36	10013-29	Carbon Film 2.2 K ±5% 1/4 W (Assembly 12667)
A3R36	--	Not Used (Assembly 12830)
A3R37	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W
A3R38	10013-31	Carbon Film 3.3 KΩ ±5% 1/4 W
A3R39	10013-43	Carbon Film 33 KΩ ±5% 1/4 W
A3R40	10013-47	Carbon Film 68 KΩ ±5% 1/4 W
A3R41	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A3R42	10013-49	Carbon Film 100 KΩ ±5% 1/4 W
A3R43	10015-133	Metal Film 49.9 KΩ ±1% 1/8 W
A3R44	10015-97	Metal Film 12.7 KΩ ±1% 1/8 W
A3R45	10015-7	Metal Film 10.0 KΩ ±1% 1/8 W
A3R46	10015-44	Metal Film 255 Ω ±1% 1/8 W
A3R47	10015-21	Metal Film 4.64 KΩ ±1% 1/8 W
A3R48	10015-30	Metal Film 7.68 KΩ ±1% 1/8 W
A3R49	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R50	10013-29	Carbon Film 2.2 KΩ ±5% 1/4 W (Assembly 12667)
A3R50	--	Not Used (Assembly 12830)
A3R51	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R52	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R53	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R54	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R55	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R56	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R57	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R58	10013-33	Carbon Film 4.7 KΩ ±5% 1/4 W
A3R59	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R60	12449-2	Metal Film 681 Ω ±0.1% 1/8 W
A3R61	12449-4	Metal Film 2.681 KΩ ±0.1% 1/8 W
A3R62	12449-5	Metal Film 7.621 KΩ ±0.1% 1/8 W
A3R63	12449-7	Metal Film 15.252 KΩ ±0.1% 1/8 W
A3R64	12449-8	Metal Film 30.58 KΩ ±0.1% 1/8 W
A3R65	12449-10	Metal Film 61.25 KΩ ±0.1% 1/8 W
A3R66	12449-12	Metal Film 122.68 KΩ ±0.1% 1/8 W
A3R67	10015-102	Metal Film 249 KΩ ±1% 1/8 W
A3R68	10015-45	Metal Film 499 KΩ ±1% 1/8 W
A3R69	10013-61	Carbon Film 1 MΩ ±5% 1/4 W
A3R70	10015-15	Metal Film 21.5 KΩ ±1% 1/8 W
A3R71	12449-3	Metal Film 1.831 KΩ ±0.1% 1/8 W
A3R72	12449-21	Metal Film 10.00 KΩ ±0.1% 1/8 W
A3R73	12449-18	Metal Film 7.50 KΩ ±0.1% 1/8 W
A3R74	12449-18	Metal Film 7.50 KΩ ±0.1% 1/8 W
A3R75	12449-9	Metal Film 37.647 KΩ ±0.1% 1/8 W
A3R76	12449-6	Metal Film 13.617 KΩ ±0.1% 1/8 W
A3R77	10013-9	Carbon Film 47 Ω ±5% 1/4 W
A3R78	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3R79	10015-203	Metal Film 280Ω ±1% 1/8 W (Assembly 12667)
A3R79	10015-93	Metal Film 562 Ω ±1% 1/8 W (Assembly 12830)
A3R80	10013-9	Carbon Film 47Ω ±5% 1/4 W
A3R81	10015-50	Metal Film 1.47 KΩ ±1% 1/8 W (Assembly 12667)
A3R81	10015-20	Metal Film 1.10 KΩ ±1% 1/8 W (Assembly 12830)
A3R82	10013-3	Carbon Film 15 Ω ± 5%, 1/4 W (Assembly 12667)
A3R82	10013-5	Carbon Film 22Ω ± 5% 1/4W (Assembly 12830)
A3R83	10013-3	Carbon Film 15 Ω± 5% 1/4 W (Assembly 12667)
A3R83	10013-5	Carbon Film 22 Ω± 5% 1/4 W (Assembly 12830)
A3R84	10013-21	Carbon Film 470Ω ±5% 1/4 W
A3R85	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A3R86	10013-21	Carbon Film 470 Ω ±5% 1/4 W
A3R87	10013-25	Carbon Film 1 KΩ ±5% 1/4 W
A3U1	11270-10	SN7490N
A3U2	12448	F9334 (Fairchild)
A3U3	11270-2	SN7404N
A3U4	11270-1	SN7400N
A3U5	11230	710C
A3U6	11270-1	SN7400N
A3U7	11270-16	SN7474N
A3U8	11270-16	SN7474N
A3U9	11270-1	SN7400N
A3U10	--	Not Used
A3U11	--	Not Used
A3U12 thru A3U19	12664	2533 (Signetics) Assembly 12667
A3U12 thru A3U19	12822	MM5056H (National Semiconductor) Assembly 12830
A3U20	12447	F9322 (Fairchild)
A3U21	12447	F9322 (Fairchild)
A3U22	11118	CA3039 (RCA)
A3U23	11627	LM301A (National Semiconductor)
A3U24	11627	LM301A (National Semiconductor)
A3U25 thru A3U32	12822	MM5056H (National Semiconductor) Assembly 12830

DET. W/LOW +10 dBm OUTPUT
P.C. BOARD
ASSEMBLY - 14196

A4CR1	10043	IN4148
A4R1	13300-3	Variable Comp 20 KΩ ±20% 1/2 W
A4R2	10013-57	Carbon Film 470 KΩ ±5% 1/4 W
A4R3	10015-16	Metal Film 18.7 KΩ ±1% 1/8 W
A4R4	10015-13	Metal Film 100 KΩ ±1% 1/8 W

PART NO. CROSS REFERENCE		
PM PART NO.	MFGR. CODE	MFGR. PART NO.
10000-1	56289	5GA-T10
10000-2	56289	5GA-T22
10000-3	56289	5GA-T47
10000-4	56289	5GA-D10
10000-5	56289	5GA-D22
10000-6	56289	5GAB-D47
10000-8	56289	5GAS-S20
10000-10	91418	Type TA 0.1 µF
10000-11	84171	TCP-R01
10000-12	56289	5GA-T15
10001-2	56289	10TCC-V47
10001-3	56289	10TCC-Q10
10001-5	56289	10TCC-Q33
10001-6	56289	10TCC-Q47
10001-8	56289	10TCC-Q15
10001-9	56289	10TCC-V68
10001-13	56289	10TCC-Q12
10007-1	01002	75F1R2A 102
10007-4	01002	75F1R2A 103
10007-5	01002	75F1R2A 223
10007-6	01002	75F1R2A 473
10007-7	01002	75F1R2A 104
10007-9	01002	75F1R2A 474
10011-2	27556	ZA1652K
10013-1	73445	B803104NB 100
10013-3	73445	B803104NB 150
10013-5	73445	B803104NB 220
10013-9	73445	B803104NB 470
10013-11	73445	B803104NB 680
10013-13	73445	B803104NB 101
10013-17	73445	B803104NB 221
10013-21	73445	B803104NB 471
10013-25	73445	B803104NB 102
10013-27	73445	B803104NB 152
10013-29	73445	B803104NB 222
10013-31	73445	B803104NB 332
10013-33	73445	B803104NB 472
10013-35	73445	B803104NB 682
10013-37	73445	B803104NB 103
10013-39	73445	B803104NB 153
10013-41	73445	B803104NB 223
10013-43	73445	B803104NB 333
10013-47	73445	B803104NB 683
10013-49	73445	B803104NB 104
10013-51	73445	B803104NB 154
10013-53	73445	B803104NB 224
10013-55	73445	B803104NB 334
10013-57	73445	B803104NB 474
10013-59	73445	B803104NB 684
10013-61	73445	B803104NB 105

PART NO. CROSS REFERENCE		
PM PART NO.	MFGR. CODE	MFGR. PART NO.
10015-7	91637	RN55D, 10.0 KΩ 1%
10015-13	91637	RN55D, 100 KΩ 1%
10015-15	91637	RN55D, 21.5 KΩ 1%
10015-19	91637	RN55D, 1.00 KΩ 1%
10015-20	91637	RN55D, 1.10 KΩ 1%
10015-21	91637	RN55D, 4.64 KΩ 1%
10015-22	91637	RN55D, 10.7 KΩ 1%
10015-25	91637	RN55D, 61.9 KΩ 1%
10015-28	91637	RN55D, 23.7 KΩ 1%
10015-30	91637	RN55D, 7.68 KΩ 1%
10015-31	91637	RN55D, 3.16 KΩ 1%
10015-32	91637	RN55D, 3.83 KΩ 1%
10015-34	91637	RN55D, 162 KΩ 1%
10015-40	91637	RN55D, 43.2 KΩ 1%
10015-41	91637	RN55D, 48.7 KΩ 1%
10015-44	91637	RN55D, 255 Ω 1%
10015-45	91637	RN55D, 499 KΩ 1%
10015-47	91637	RN55D, 2.49 KΩ 1%
10015-54	91637	RN55D, 110 KΩ 1%
10015-58	91637	RN55D, 9.76 KΩ 1%
10015-61	91637	RN55D, 39.2 KΩ 1%
10015-63	91637	RN55D, 402 KΩ 1%
10015-65	91637	RN55D, 4.99 KΩ 1%
10015-67	91637	RN55D, 143 KΩ 1%
10015-70	91637	RN55D, 681 Ω 1%
10015-71	91637	RN55D, 909 Ω 1%
10015-73	91637	RN55D, 10.2 KΩ 1%
10015-74	91637	RN55D, 2.00 KΩ 1%
10015-79	91637	RN55D, 2.67 KΩ 1%
10015-80	91637	RN55D, 4.02 KΩ 1%
10015-84	91637	RN55D, 2.10 KΩ 1%
10015-85	91637	RN55D, 287 KΩ 1%
10015-90	91637	RN55D, 24.9 KΩ 1%
10015-91	91637	RN55D, 90.9 KΩ 1%
10015-93	91637	RN55D, 562 Ω 1%
10015-97	91637	RN55D, 12.7 KΩ 1%
10015-99	91637	RN55D, 14.0 KΩ 1%
10015-101	91637	RN55D, 20.5 KΩ 1%
10015-102	91637	RN55D, 249 KΩ 1%
10015-105	91637	RN55D, 6.19 KΩ 1%
10015-114	91637	RN55D, 75 KΩ 1%
10015-116	91637	RN55D, 30.1 KΩ 1%
10015-120	91637	RN55D, 69.8 KΩ 1%
10015-123	91637	RN55D, 301 Ω 1%
10015-133	91637	RN55D, 49.9 KΩ 1%
10015-159	91637	RN55D, 402 Ω 1%
10015-170	91637	RN55D, 348 Ω 1%
10015-179	91637	RN55D, 140 KΩ 1%
10015-183	91637	RN55D, 80.6 KΩ 1%

PART NO. CROSS REFERENCE		
PM PART NO.	MFGR. CODE	MFGR. PART NO.
10015-188	91637	RN55D, 33.2 KΩ 1%
10015-191	91637	RN55D, 66.5 KΩ 1%
10015-206	91637	RN55D, 7.50 KΩ 1%
10015-207	91637	RN55D, 20.0 KΩ 1%
10015-208	91637	RN55D, 124 KΩ 1%
10015-209	91637	RN55D, 130 KΩ 1%
10015-211	91637	RN55D, 2.74 KΩ 1%
10015-213	91637	RN55D, 178 KΩ 1%
10018	07263	2N3646
10019	07263	2N3565
10023	07263	2N3644
10043	09214	1N4148
10045	07910	1N823
10046-1	71450	X201R501B
10046-6	71450	X201R201B
10046-8	71450	X201R103B
10046-10	71450	X201R104B
10046-13	71450	X201R105B
10133-3	00656	Type CN, NPO 1.0 pF
10140-1	74970	105852
10140-2	74970	105857
10140-3	74970	105853
10140-4	74970	105860
10142-2	01121	CB1565
10206	07263	2N3053
10209	90634	51RD21
10630-1	72982	538-011,2-8 pF, A
10769	04713	MC1709CG
10787-2	12954	D12GSB20M
10787-3	12954	D27GSB15M
10787-4	12954	D68GSC15M
10787-5	12954	D1R0GSA15M
10787-6	12954	D2R7GSA15M
10896	02735	3N138
10909-4	84171	DM-19F242F
10909-5	84171	DM-19F472F
10920-1	99800	2890-42
11117	02735	CA3026
11118	02735	CA3039
11119	07263	2N4250
11230	07263	U5B7710393
11270-1	01295	SN7400N
11270-2	01295	SN7404N
11270-8	01295	SN7473N
11270-10	01295	SN7490N

PART NO. CROSS REFERENCE		
PM PART NO.	MFGR. CODE	MFGR. PART NO.
11270-15	01295	SN7410N
11270-16	01295	SN7474N
11432	27014	FM3955
11457	28821	11457
11501-2	72982	8131-050-651-104M
11507	01295	TIS97
11539	07263	U5B7741393
11585	01295	TIS59
11627	27014	LM301AH
11676-1	01121	WA1GØ12S1Ø4MZ
11711-3	73138	66WR 2ØK
11715	01295	1N4446
12260	81095	SP-66
12439	02735	2N5785
12445	07263	U5T7725393
12446	18324	N2527V
12447	07263	9322
12448	07263	9334
*13300-3	71450	375T103B
12449-2	14298	EE 1/8 C2 681.0 Ω 0.1%
12449-3	14298	EE 1/8 C2 1.831 KΩ 0.1%
12449-4	14298	EE 1/8 C2 2.681 KΩ 0.1%
12449-5	14298	EE 1/8 C2 7.621 KΩ 0.1%
12449-6	14298	EE 1/8 C2 13.617 KΩ 0.1%
12449-7	14298	EE 1/8 C2 15.252 KΩ 0.1%
12449-8	14298	EE 1/8 C2 30.58 KΩ 0.1%
12449-10	14298	EE 1/8 C2 61.25 KΩ 0.1%
12449-12	14298	EE 1/8 C2 122.68 KΩ 0.1%
12449-13	14298	EE 1/8 C2 18.75 KΩ 0.1%
12449-14	14298	EE 1/8 C2 37.50 KΩ 0.1%
12449-15	14298	EE 1/8 C2 75.00 KΩ 0.1%
12449-16	14298	EE 1/8 C2 150.00 KΩ 0.1%
12449-17	14298	EE 1/8 C2 187.50 KΩ 0.1%
12449-18	14298	EE 1/8 C2 7.50 KΩ 0.1%
12449-21	14298	EE 1/8 C2 10.00 KΩ 0.1%
12449-22	14298	EE 1/8 C2 2.50 KΩ 0.1%
12449-23	14298	EE 1/8 C2 375.0 KΩ 0.1%
*13503-1	75915	276-.500
12468	28821	12468
12474	07263	FCD-810
12475	07126	28001-3 Modified
12478	71590	12478
12479	71590	12479
12483	09353	8632
12492	19477	850-10T-5K
12564	82389	57HA3F
12591	17856	E112
12664	18324	2533
12690	76854	399633-511
12799	17856	E109
12822	27014	MM5056H
12942	07263	2N2905A
13533	04713	2N2907/2N2907A
13534	04713	2N2221/2N2221A

*Out of Sequence

FEDERAL SUPPLY CODE FOR MANUFACTURERS

The following five-digit code numbers are listed in numerical sequence along with the manufacturer's name and address to which the code has been assigned.

The Federal Supply Code has been taken from Cataloging Handbook H 4-2, Code to Name.

00303	Shelly Associates Inc. El Segundo, California.
00656	Aerovox Corp. New Bedford, Massachusetts
00779	AMP Inc. Harrisburg, Pennsylvania
01002	General Electric Co. Capacitor Dept. Hudson Falls, New York
01121	Allen-Bradley Co. Milwaukee, Wisconsin
01295	Texas Instruments, Inc. Semiconductor Components Div. Dallas, Texas
01961	Pulse Engineering Inc. Santa Clara, California
02114	Ferroxcube Corp. of America Saugerties, New York
02660	Amphenol-Borg Elect. Corp. Broadview, Illinois
02735	Radio Corp. of America Semiconductor and Materials Div. Somerville, New Jersey
04062	Elmenco Products Co. New York, N.Y.
04713	Motorola, Inc. Semiconductor Products Div. Phoenix, Arizona
07263	Fairchild Camera and Inst. Corp. Semiconductor Div. Mountain View, California
07910	Continental Device Corp. Hawthorne, California
09214	General Electric Co. Semiconductor Products Dept. Auburn, New York
09353	C and K Components Inc. Newton, Massachusetts
11711	General Instruments Inc. Semiconductor Div. Newark, New Jersey
12674	Syncro Corp. Hicksville, Ohio
12954	Dickson Electronics Corp. Scottsdale, Arizona
14298	American Components, Inc. Conshohocken, Pennsylvania
18324	Signetics Corp. Sunnyvale, Calif.
24931	Speciality Connector Co. Inc. Indianapolis, Indiana
25088	Siemens America Corp. Iselin, New Jersey
27014	National Semiconductor Corp. Santa Clara, California
27556	IMB Electronic Products Santa Fe Springs, California
28480	Hewlett-Packard Co. Palo Alto, California
28821	Pacific Measurements Inc. Palo Alto, Califomia
56289	Sprague Electric Co. North Adams, Massachusetts
71034	Bliley Electric Co. Erie, Pa.
70903	Belden Mfg. Co. Chicago, Illinois
71400	Bussman Mfg. Div. of McGraw-Edison Co. St. Louis, Missouri
71450	CTS Corp. Elkhart, Indiana
72982	Erie Tech. Products Inc. Erie, Pennsylvania
73138	Beckman Instruments Inc. Helipot Division Fullerton, California
73445	Amperex Electronic Corp. Hicksville, New York.

74970	E. F. Johnson Co. Waseca, Minnesota
75915	Littlefuse Inc. Des Plaines, Illinois
76854	Oak Mfg. Co. Crystal Lake, Illinois
76493	J. W. Miller Company Compton, Calif.
76541	Monsanto Commercial Products Co. Cupertino, Calif.
79727	Continental-Wirt Electronics Corp. Philadelphia, Pa.
82389	Switchcraft Inc. Chicago, Illinois
83594	Burroughs Corp. Electronic Components Div. Plainfield, New Jersey
84171	Arco Electronics Inc. Great Neck, New York
90634	Gulton Industries Inc. Metuchen, New Jersey
91418	Radio Materials Co. Chicago, Illinois
91637	Dale Electronics Inc. Columbus, Nebraska
91929	Honeywell Inc. Microswitch Div. Freeport, Illinois
94144	Raytheon Co. Components Div. Quincy, Massachusetts
99800	Delavan Electronics Corp. East Aurora, New York.

ADDITIONAL FEDERAL SUPPLY CODE FOR MANUFACTURERS

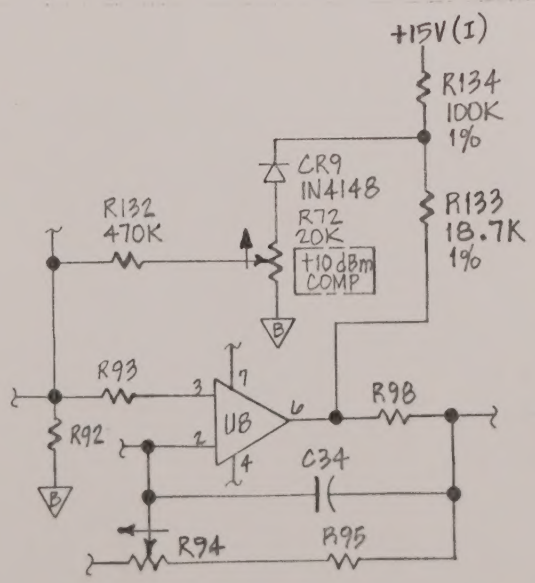
07126	Digitran Co. Pasadena, Calif.
17856	Siliconix Santa Clara, Calif.
19447	Electro-Technique Inc. Oceanside, Calif.
22526	Berg Electronics Corp. York Expressway New Cumberland, Pa. 17070
32284	Rotron Manufacturing Co. Inc. Woodstock, New York
71590	Centralab Electronics Milwaukee, Wisconsin
81095	Traid Transformer Corp Venice, California
81483	International Rectifier Corp. El Segundo, Calif.
83330	H. H. Smith, Inc. Brooklyn, New York
83701	Electronic Devices, Inc. Yonkers, New York 10710
95146	Alco Electronics Lawrence, Mass.
99392	STM Corp. Oakland, Calif. 94601

SECTION 9

MANUAL CORRECTIONS

This section lists the corrections that must be incorporated in this manual to make it correspond to a particular instrument. The serial number of each instrument is prefixed by a code number. This code number is used to identify the applicable manual corrections for a particular instrument. When correcting this manual start with the corrections corresponding to the Code No. on the instrument. If a particular component has been changed more than one time, make only the first change encountered.

CODE NO.	CORRECTIONS	PM PART NO.	SECTION OF MANUAL AFFECTED
16	None		
17	Add A2C9 Ceramic Capacitor .001μ F from isolated Common to common,	10000-4	7, 8
18	Change A2C11 from 15 pF (10001-8) to 30 pF. Change A2C59 and A2C61 from .001mF (10000-4) to 1000pF	10001-20 10677-18	7, 8 7, 8
19	Change A2R176 from 4.7KΩ (10013.33) to 4.02 KΩ, 1% Change A2R177 from 470 Ω (10013-2) to 392 Ω, 1% Add +10 dBM Circuitry to Schematic 12433 Sht. 2 of 4: Add A2R72: Variable 20KΩ Add A2R132: 470KΩ Add A2R133: 18.7KΩ 1% Add A2R134: 100KΩ 1% Add A2CR9: IN4148	10015-80 10015-158 13300-3 10013-57 10015-16 10015-13 10043	7, 8 7, 8 7, 8 7, 8 7, 8 7, 8 7, 8



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